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Some unusually deep plate girders are being used in the bridge now being built to carry the double tracks of the Georges Creek & Cumberland R. R. over Will's Creek, near Cumberland, Md. The bridge will be built on a curve of 12 degrees, and will consist of two spans. Each span will consist of two plate girders, 92 ft. long and 9 ft. deep, placed 33 ft. c to c. of girders. The Pennsylvania Steel Co., of Steelton, Pa., is the contractor, and the bridge is to be completed by June 15, 1892.

The gross earnings of 130 railways, operating 99,264 miles of road, for the month of March, are $44,545,382, according to the "Financial Chronicle." This is an increase of 2.75 per cent. in mileage, and 8.54 per cent. in earnings, over the corresponding month of 1891. As in the previous months of the year the best showing is made by the grain carrying roads in the Northwest and Southwest. The Southern roads continue to show the poorest results. Of the 42 railways exhibiting decreases, 19 are comprised in the Southern group. The Middle and Middle Western roads exhibit generally favorable results. Increases of over $30,000 each are shown by 26 roads, and 3 roads have decreases of the same amount. Two lines, the Chicago, Milwaukee & St. Paul, and the Great Northern, have gains of $609,148 and $562,000, respectively.

A great real estate boom between Niagara Falls and Buffalo has resulted from the water power works at the Falls. Over the entire distance of about 17 miles, between the village of Niagara Falls and the built-up portion of Buffalo, the land is held at speculative prices, and very little of it can be bought at all, though until recently it was cheap "acre property." Opinions differ as to whether the greater portion of the power will be used near the Falls or carried to Buffalo, but in either case, a great manufacturing development is expected between the two cities, and not unreasonably.

A new trainshed is to be built at the Illinois Central R. R. terminus at New Orleans, La. It will be 500 ft. long and 175 ft. wide, covering nine tracks, and is to be completed by July. The contract has been awarded to the Kenwood Bridge Co., Chicago, Ill.

A water power franchise on the Canadian side of Niagara Falls has been granted to the "Canadian Niagara Power Co.," which appears to be practically the Cataract Construction Co., which is at work on the other side of the river, Messrs. F. L. Stetson and W. B. Rankin, Vice-President and Secretary of the latter company, being two of the three members of the Canadian company, while the third is an American. The company undertakes to have 25,000 HP. developed and 10,000 HP. ready for use by November, 1893. The rental is to increase gradually to a maximum of $35,000 per year at the end of 20 years.

The most serious railway accident of the week was a crossing collision at Monticello, Ill., April 16. A freight train on the Wabash Ry. ran into an Illinois Central R. R. freight train, wrecking several cars. Three men were killed and three others injured. A head collision occurred April 18 on the New York & New England R. R. at Black Rock, Conn. The eastbound Long Island express was run into by a westbound passenger train. The engines were wrecked and two men were injured.

One span of a bridge on the Chesapeake & Ohio Ry. at Huntington, W. Va., was knocked down by a derailed freight car, April 9. Mr. H. Frazier, Chief Engineer, states that the whole structure consisted of three iron Pratt through truss spans of 101 ft. 6 ins. each, and was built about five years ago. A westbound freight train moving very slowly, in order to take a siding just west of the bridge, had a flat car off the track, being the third car from the caboose. The point of derailment of this car was about half a mile from the east end of the bridge. The engineman looking ahead to the switch signal did not look in time to prevent this car from striking the end post, which knocked the east span down. Four empty flat cars went into the river, the caboose having been cut off by the brakeman, who saw that the engineman's attention would not be attracted in time. The train consisted of about 40 empty cars. The false work was put up in seven hours, and traffic resumed. The other two spans were not in any way injured.

A serious explosion occurred April 18 at the works of the American Forcite Powder Co., at Lake Hopatcong, near Mount Arlington, N. J. The superintendent and six men were blown to pieces and two men were injured. The works consist of a number of small buildings, five of which were wrecked.

The Worthington high duty pumping engine at Lowell, Mass., showed 116,208,007 ft. lbs. per 1,000,000 heat units delivered to it in the test made by Mr. Geo. H. Barrus. In the tabular report of the test in our last issue the left hand figure was omitted.

A turbine water-wheel 15 ft. in diameter is being built at the works of Jas. Leffel & Co., Springfield, O. It is designed to develop about 600 HP., and will work under a moderate head. The wheel is to be set vertically.

Alumina, or oxide of aluminum, from which the metal is extracted by the aid of electricity in the processes now in use, was at first imported from Germany. Last summer the Solvay Process Co., of Syracuse, N. Y., took up the manufacture, and are now turning out an excellent grade of alumina. The price is about 7 cts. per lb. in car load lots. The alumina is obtained from bauxite, a mineral which occurs in abundance in Northwestern Georgia and some other parts of the South.

A locomotive with a double barrel boiler has been designed by the mechanical engineer of the Eastern Railway, of France, and has been built at the company's works. The lower barrel is filled with tubes, and is connected with the upper barrel by three necks and by the throat plate of the firebox shell. The object is to have a boiler of large capacity without increasing the diameter beyond 4 ft. 4 ins., so that it may fit between the driving wheels. The engine is of the eight-wheel type, with outside cylinders at about the middle of the engine, and driving the rear pair of driving wheels, this arrangement being considered best for high speeds. The valve motion is also outside. The four driving wheels are 6 ft. 6 ins. diameter, and there is a four-wheel leading truck, with plate frames, and outside bearings. The engine is designed for hauling heavy passenger trains, and maintaining a continuous high rate of speed.

An electric lighting plant, driven by a windmill, is in operation in a London flour mill, according to "The Engineer." The windmill is of the well-known Halliday type, made by the United States Wind Engine & Pump Co., of Batavia, Ill. It is 30 ft. in diameter. A reasonably uniform speed is obtained by the construction of the wheel. Whenever the force of the wind is such as to give the wheel the necessary speed, a connection is automatically made, and the wheel drives a dynamo, which furnishes current to a storage battery of 28 cells. An automatic switch reduces the current when the speed is too high, and prevents too much current being forced into the battery at any one time. The current obtained from the storage battery is sufficient to operate two 1,500 c. p. arc and several incandescent lamps.

Electric traveling cranes, taking the current from overhead trolley wires, are being put in at the new Grant Locomotive Works, Chicago. The crane in the erecting shop is of 40 tons capacity, and is equipped with five motors. The hoisting equipment is double, and consists of two 12 HP. motors, while there are two 4 HP. motors for traversing, and one 8 HP. motor for traveling. The crane girder has a span of 78 ft. between rails, and is 6 ft. deep. The travel is 400 ft. A double trolley is used. The crane in the boiler shop is of 20 tons capacity, and has one 12 HP. motor for hoisting, another of 8 HP. for traveling, and a third of 4 HP. for traversing. It has a span of 57 ft. 6 ins., and a travel of 247 ft. The crane in the foundry is also of 20 tons capacity, with three motors of 8, 6 and 2 HP. respectively for hoisting, traveling and traversing. It has a span of 50 ft., and a travel of 263 ft.

An important contract for signal plant has been awarded by the Illinois Central R. R. to the Hall Signal Co., of New York, for the purpose of protecting the very heavy traffic at Chicago. The system adopted is the Hall automatic electric block system, which was described in Engineering News, Sept. 13 and 20, 1890, and which has been adopted by the Chicago & Northwestern Ry. for about 87 miles of its lines in and near Chicago (Eng. News, Feb. 6, 1892). The plant for the Illinois Central R. R. will be somewhat different from that for the Chicago & Northwestern Ry. From the new terminal station to be built by the company, at Twelfth St., to Grand Crossing, about ten miles, there will be eight tracks. Over these tracks the signals will be placed, 2,000 ft. apart, on steel bridges spanning the tracks, so that each signal will be immediately over the track it governs. From Grand Crossing to Kensington, about five miles, there will be four tracks. These will also be spanned by steel bridges with the signals attached. The adoption of this block system has been decided upon with a special view to safety and convenience in handling the heavy local and main line traffic at the time of the World's Columbian Exposition next year, and the matter has been under consideration for some time by Mr. J. F. Wallace, Chief Engineer, and Mr. A. W. Sullivan, General Superintendent.

The "Huckleberry" street railway bill has passed the New York Senate by a vote of 19 to 13. This bill practically gives to its promoters a monopoly of street railways in the annexed district of the city of New York; and as its gross receipts will probably never exceed $1,700 per day, fixed as a point above which it is to pay a percentage to the city, it is practically exempt from taxation. The bill also exempts this railway from the Cantor act, requiring the sale of the franchise at auction. In defending this bill, Senator Brown made the very remarkable statement that he was "authorized" to say that any Senator objecting to the liberal provisions of the bill was at liberty to invest his capital in the stock of the proposed road; and he was "further authorized to say that everybody interested in this road was willing to divide." The suspicion is natural that the liberal promoters did divide.

The Midland Railway Co., of Western Australia, whose office is in London, England, has made arrangements for the completion of its line, the interest on the issue of $2,500,000 in debentures having been guaranteed by the colonial government of Western Australia and the National Bank of Australasia.

The first iron steam vessel built, says a correspondent of "The Engineer," was built by the Horseley Co., in 1821, at Tipton, Staffordshire. Mr. Grantham, in his work on shipbuilding, describes an iron canal boat, built in 1787 by a J. Wilkinson, of Bradley Forge, near Bilston. And in 1815, Mr. Thomas Jevons launched a small iron boat on the Mersey. It was built by Joshua Horton, near Birmingham, and is said to have been the first iron boat that floated on salt water. Knight's Mechanical Dictionary, in referring to the Wilkinson boat, says it was 70 ft. long by 6 ft. 8½ in. beam. It was built of 5-16 in. plates, fastened by rivets, and had a wooden frame. The weight was 8 tons, with a capacity of 32 tons, and the draft was 8 to 9 ins. light. The Jevons iron pleasure boat on the Mersey was scuttled by jealous shipbuilders, as was an iron lifeboat, built by the same man in 1817.

Work on the Chignecto Ship Ry. is likely to be resumed early in May, according to the "Amherst Record." It is stated that funds have been raised in England sufficient to complete the road, and it is hoped to transport at least one vessel across before the close of navigation in order to secure the Dominion subsidy of $165,000 per annum for 20 years. At the recent annual meeting in London it was stated that the work could readily be completed in six months at a further expenditure of about $1,000,000.

An illuminated semaphore signal which dispenses with colored lights and indicates by position only, is on trial by the Pennsylvania R. R. at Wilkinsburg. The signal is the invention of Messrs. J. J. G. Schender and V. Snicer, of the Union Switch and Signal Co. and is controlled by that company.

TRAINSHED FOR THE NEW UNION PASSENGER STATION, ST. LOUIS, MO.

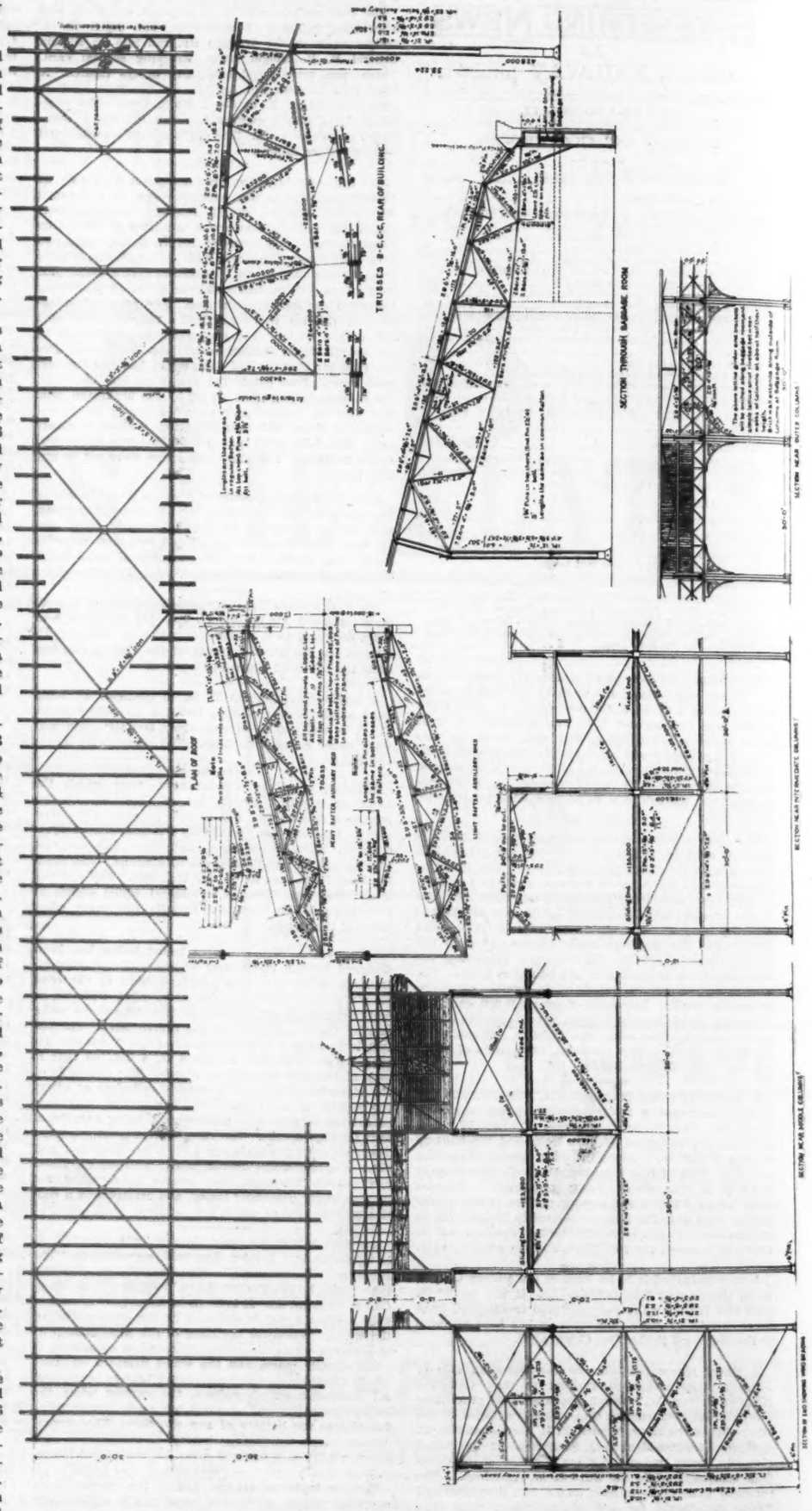
(With inset.)

A general plan of the new terminal station and trainshed to be built at St. Louis, Mo., was given in our issue of April 2, together with interior and exterior views of the trainshed. In the present article we give the strain sheet of trusses, details of roof trusses and columns, and the details of the foundations for the 92 columns of the trainshed. In a later issue we shall give particulars of the front and rear ends and the wind bracing. The construction and arrangement of parts are very clearly shown on the drawings on our inset sheet. As described in the article above referred to, the trainshed is 700 ft. long and 601 ft. wide, with two exterior and three interior rows of columns, and containing 30 tracks. It was designed by Mr. George H. Pegram, Consulting Engineer.

The ground is of variable character, some parts being solid and other parts filled in, and there are a few artificial obstructions. The foundations consist of concrete piers resting upon solid ground or upon piling, and capped with stone, as shown by the accompanying drawings. The piers for the outside rows of columns have a base of 9 ft. by 11 ft. 6 ins., with piles, or 9 ft. by 12 ft., without piles, and are reduced by offsets to a uniform size of 4 ft. by 6 ft. at the top. The piers for interior columns have a base of 7 ft. by 8 ft. to 8 ft. by 9 ft., on piles, or 8 ft. by 9 ft. to 9 ft. by 10 ft., without piles, and are reduced by offsets to a size of 4 ft. by 5 ft., 4 ft. by 6 ft., or 5 ft. by 6 ft. on top, according to location. The bottom of each excavation is to be rammed and drained, and the back filling well tamped in layers 6 ins. thick. The piles are to be of white oak or red cypress, not less than 10 ins. diameter at the small end, and with the bark removed. They will be driven to a ½-in. set from a 2,500-lb. hammer falling 25 ft. The piles will be sawed off to a level plane, and the ground around and between them thoroughly tamped.

The piers will be built of Portland cement concrete mixed in proportions of 1 part of cement to 3 of sand and 6 of broken stone. The cement is to have a minimum strength of 400 lbs. per square inch when tested in briquettes which have been 24 hours in air and 7 days in water. The sand is to be clean, coarse, sharp river sand. The stone is to be of approved quality, broken to pass through a 2½-in. ring, and screened, and if too dusty or dirty it is to be washed. The cement and sand will be thoroughly mixed dry and then mixed with water. The stone, having been previously wetted, is then to be added, and the mass worked until all the stones are well coated with mortar. The concrete is then to be immediately deposited and tamped in layers of about 6 ins., within wooden forms which are not to be removed until after the concrete has set. Care must be taken to use the least amount of water necessary. The concrete for the outside columns will be deposited continuously until the pier is completed, but the concreting of the interior piers may be stopped at the level of an offset when required. Wooden frames will be used to hold the anchor bolts in position during the construction of the pier. The capstones will be of granite or limestone, the former being used probably for the exterior and the latter for the interior piers. They are specified to be of best quality and of uniform grade and color. The top will be bush hammered, with a 1-in. beveled chisel draft around the edges, and the four sides will be hammer dressed to a depth of 6 ins. from the top, the lower part of the sides being rock faced. The stones will be set in a bed of mortar composed of 1 part cement to 2 of sand, freshly mixed, the mortar joint to be not less than ⅜ in. nor more than ¾ in. thick. The spaces round the anchor bolts will be filled in with Portland cement mortar composed of 1 part cement to 1 of sand.

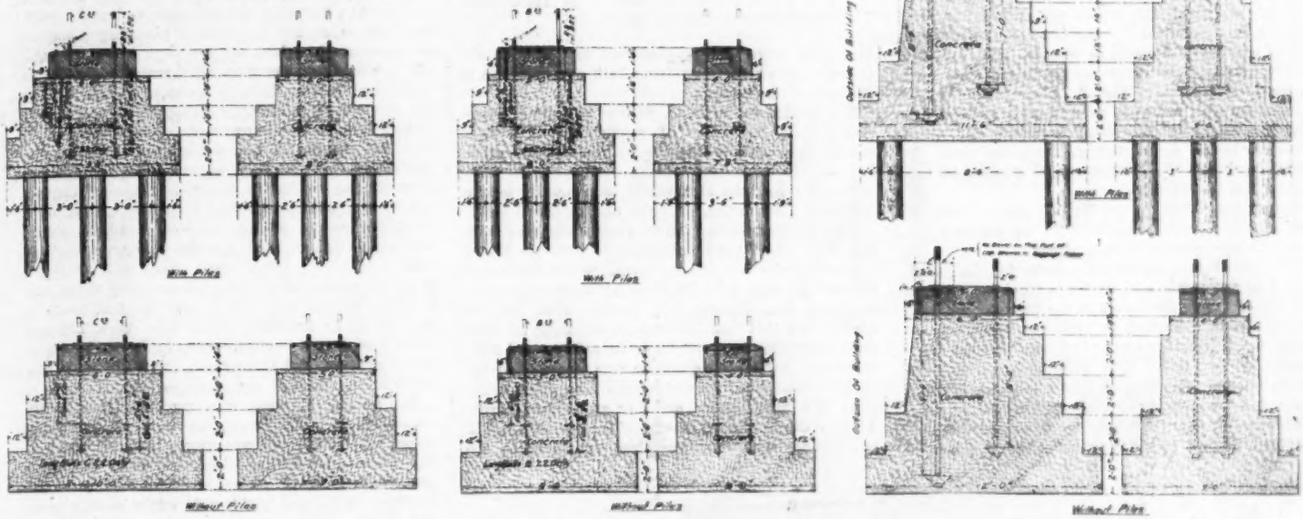
The anchor bolts for the outer piers are 2 and 2½ ins. diameter, with the upper 6 or 7 ins. upset and threaded. They are about 8 ft. 6 ins. to 10 ft. 6 ins. long, 17½ to 24½ ins. projecting above the capstones. The lower ends of each pair are connected by cast iron washers, as shown. For the interior piers the anchor bolts are 1¼ ins., 1⅝ ins. and 2 ins. diameter, 4 ft. to 5 ft. 6 ins. long from washer to top of caps. The ends are not upset, and a separate round washer is used on the end of each



DETAILS OF ROOF TRUSSES AND COLUMNS FOR ST. LOUIS TRAINSHED; GEO. H. PEGRAM, ENGINEER.

bolt. All the interior foundations will be as shown on the drawings, with the exception of those for the four north end piers, which are larger, and for five piers at the baggage room.

The trainshed itself is an interesting and important work, both from its design and its great size. The columns, trusses and purlins will be generally of steel, and all other parts generally of iron. Steel is to be used except where iron is specified. The steel is to have an ultimate strength of 60,000 lbs. per sq. in., with 4,000 lbs. allowance either way. It is to be reamed in tension members, but need not be reamed in compression members



Column C. Column B. Column A.

FOUNDATIONS FOR COLUMNS; TRAINSHED FOR NEW UNION PASSENGER STATION, ST. LOUIS, MO.

except to avoid the use of drift pins. The specifications require the quality of materials and workmanship to be in accordance with the Bridge Builder's specifications, as given in Carnegie, Phipps & Co's. "Pocket Companion," edition of 1890. In the latest edition of this "Pocket Companion," however, as noted in our issue of April 9, the Bridge Builder's specifications are replaced by Mr. Theodore Cooper's standard specifications. Where truss rods are connected at the ends with rivets, the holes need not be bored, but must be of proper diameters to suit the rivets used. The specifications suggest that the manufacture of the bent truss rods may be facilitated by using washers of various diameters on the post rivets, thereby compensating for inequalities in length. The bends in these rods must be exactly in the middle.

The lumber for sheathing will be all heart yellow pine in widths of 6 ins. It will be clear of sap and dry, tongued and grooved, and milled to a thickness of 1¾ ins. The baseboards and sills of the skylights will be red cypress of the same description.

It is not decided whether iron or wooden mullions will be used for the vertical glass work. The glass in lateral skylights and in the end designs will be 3-16 in. thick, with a uniform width of 20 ins., and will be in single lengths of about 8 ft. The central ventilator will be covered with glass for its entire length. The auxiliary shed between the main trainshed and the headhouse will be covered with glass for a width of 23 ft. and a length of 600 ft. along the headhouse. The glass will be ¼ in. thick, set in metal longitudinal bars. The glass in the front and rear of the building will be 3-16 in. thick, set in iron mullions. The end trusses will be covered with galvanized corrugated iron, and there will be a galvanized iron cornice 3 ft. deep across both ends of the building and along the sides, except the 250 ft. along the baggage room. There will also be a galvanized iron frame about 1 foot deep around the glass designs in the ends of the building, and covering the columns above the brackets. All galvanized iron will be of No. 22 gage. Galvanized iron posts and louvres, extending from the sills to the eaves, will be fitted in the central and lateral skylights. The roof sheathing will be covered with a thick layer of roofing felt, lapped and tacked, and then covered with I. C. tin. The seams are to be well soldered, using resin as a flux, the solder being thoroughly soaked into the seams. Standing seams are to be used on the portions of the sides of the main shed, extending from the gutters to a distance of 10 ft. above the ends of lateral skylights and on the auxiliary shed, flat seems to be used on other portions of the roof. All roof sheets are to be 28 x 20 ins., showing 18½ x 26½ ins. for a flat seam, and 18⅞ x 25¼ ins. for standing seam when laid on the roof.

The tin and galvanized iron work will receive two coats on both sides. The paint is to be red lead, mixed with 1 ounce of lamp black per lb. and pure linseed oil. The iron work is to be erected by and complete by Aug. 1, 1892.

The quantities required are approximately as follows:

Ironwork (detailed weights in separate table)	5,115,740 lbs.
Z-iron sills and T-iron mullions in lateral skylights (if used)	172,180 "
T-iron mullions in end designs (if used)	44,908 "
Lumber	886,000 ft. B. M.
Wooden mullions in lateral skylights (if used)	34,560 lin ft.
Wooden mullions in end designs (if used)	12,850 "
Glass in lateral skylights	51,840 sq. ft.
Glass in end designs (both ends)	22,000 "
Glass in roofs of central skylight and auxiliary shed	30,630 "
Tin	402,840 "
48 cast iron down spouts	12,000 lbs.
48 galvanized iron down spouts	900 lin. ft.
Galvanized iron, including louvres	17,920 sq. ft.
Galvanized corrugated iron	19,170 "
Galvanized iron cornices	2,260 ft.

The iron and steel work is to receive two coats of paint at the shops and one coat after erection.

The following table gives the estimate of weight of iron and steel work:

ESTIMATED WEIGHTS OF METAL FOR TRAINSHED; UNION PASSENGER STATION, ST. LOUIS, MO.

		Iron					Steel					
Main Train House.	Grand totals. lbs.	Plates. lbs.	Angles. lbs.	Rods. lbs.	Pins and riv. h'ds. lbs.	Totals. lbs.	Plates. lbs.	Angles. lbs.	Z's. lbs.	Eye-bars. lbs.	Pins and Riv. h'ds. lbs.	Totals. lbs.
66 intermediate rafters	1,205,223	4,092	....	45,954	....	50,046	47,472	770,040	....	315,813	21,252	1,154,577
44 side rafters	387,208	10,856	....	2,318	....	23,938	17,004	219,778	....	118,026	8,532	363,360
2,142 purlins	1,415,802	21,420	10,764	169,218	....	274,176	....	1,128,834	....	....	12,832	1,141,686
Central skylights	68,061	1,617	60,543	4,641	1,260	68,061	....	....	....	....	....	....
Lateral skylights	195,660	6,260	184,800	....	4,600	195,660	....	....	....	....	....	....
Bracing	372,990	6,800	180,825	42,716	2,600	232,941	4,800	7,404	122,635	5,180	....	140,049
Side lattice struts between columns	103,094	874	101,840	....	380	103,094	....	....	....	....	....	....
Brackets for same	19,320	8,400	10,920	....	....	19,320	....	....	....	....	....	....
44 truss brackets	62,436	35,156	....	....	....	35,150	....	25,256	....	....	2,024	27,280
44 outer columns (A)	173,536	7,744	....	....	....	7,744	61,424	22,528	76,808	....	4,972	165,732
44 intermediate columns (B)	136,036	....	....	....	....	....	48,244	19,008	60,480	....	8,304	136,036
24 middle columns (C)	256,664	....	....	....	....	....	96,712	25,828	120,060	....	14,064	256,664
20 longitudinal trusses (B)	214,000	....	....	....	....	....	72,940	67,440	17,400	46,500	9,720	214,000
20 longitudinal trusses (C)	244,060	....	....	....	....	....	95,220	66,600	23,060	40,220	9,960	244,060
Auxiliary Shed.												
27 rafters	114,620	....	....	4,383	....	4,383	2,200	75,901	....	29,687	2,458	110,246
Purlin and wall plates	127,954	....	....	13,266	....	13,266	....	104,588	7,020	....	3,080	114,688
Bracing:	18,917	3,005	15,912	....	....	18,917	....	....	....	....	....	....
Total	5,115,740	106,824	649,142	282,496	8,840	1,047,302	446,016	2,533,205	427,553	564,426	97,238	4,068,488

Special items not included in the above are 172,180 lbs. of iron (120,000 lbs. of plates, and 51,220 lbs. of Z's) for lateral skylights; and 44,908 lbs. of iron Z-bars for the end designs.

A National Nicaragua Canal Convention is proposed, to be held in St. Louis on June 2. Gov. Markham, of California, has addressed letters to the governors of all the states and territories, requesting them to appoint to such a convention a number of delegates equal to twice the number of senators and representatives in Congress.

TYPESETTING BY MACHINERY.
II.

The Linotype machine, by which the pages of Engineering News are now composed, is a radical departure from the typesetting machines described in our issue of April 9, on which inventors have expended so much labor and ingenuity. The Linotype machine does not set type at all; it assembles, in response to the touch of the operator upon its keyboard, a row of "matrices" or molds, thin flat pieces of brass, one of which is shown in Fig. 1, each having on one edge a letter stamped with a punch which is a fac-simile of the type it is desired to form. When this row of matrices is completed the side on which the letters are stamped is held against the front of a rectangular slot into which a jet of melted type metal is forced. This solidifies almost instantly and forms a solid line of type, seen in perspective view in Fig. 2. These solid "slugs" replace the type ordinarily used in the printing press. The machine performs these functions and other necessary ones automatically, including that old stumbling block of all inventors of typesetting machines, the justification.

Before describing the wonderfully perfect mechanism of the Linotype machine let us consider the practical advantages which it offers.

The two of greatest importance are that the justification is automatic and that the machine obviates the use of type. As stated in the preceding article, with the machines which set type, two operators are required, one working on the keyboard and the other justifying the lines. The Linotype machine requires but one operator, and as a labor-saving machine has an evident great advantage over its competitors. But what appeals most strongly to the practical printer is doing away with the use of

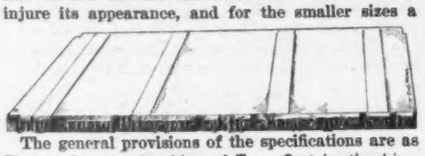


Fig. 2. Sketch of a Line of Type Cast by the Linotype Machine and, beneath it, an Actual Print from the Same Line of Type.

holding the type, composing sticks and other compositor's tools, etc., would at least double this amount. The wear of type in the press and in throwing it in the case in distribution is considerable. A few months' use is sufficient to materially injure its appearance, and for the smaller sizes a couple of years' use is about all that can be got out of type without sacrificing both appearance and the eyes of the readers.

But besides the expense, the use of type is objectionable on the score of convenience. Certainly if solid lines of type had always been used in printing and it were proposed to replace them with separate types, the idea would be generally held a mechanical absurdity. A page of "nonpareil solid" matter in Engineering News, (small size type with the lines close together) contains perhaps 30,000 separate pieces. An 8-page "form," which consists of 8 pages of type, held in place by tight wedging in a heavy iron frame, may contain over 200,000 pieces. All this "matter" has to be moved by hand from the compositor's sticks to the galleys, and from them it is taken and made up into pages. Let the reader notice in any printed column how often a hyphen, a period, comma, and i or an l (types hardly 1-32 in. thick) come at the end of the line, and he will not wonder that they are often misplaced in the

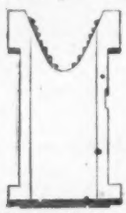


Fig. 1. Matrix.

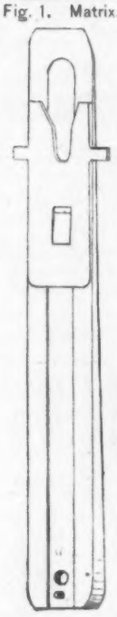


Fig. 4. Space Band.

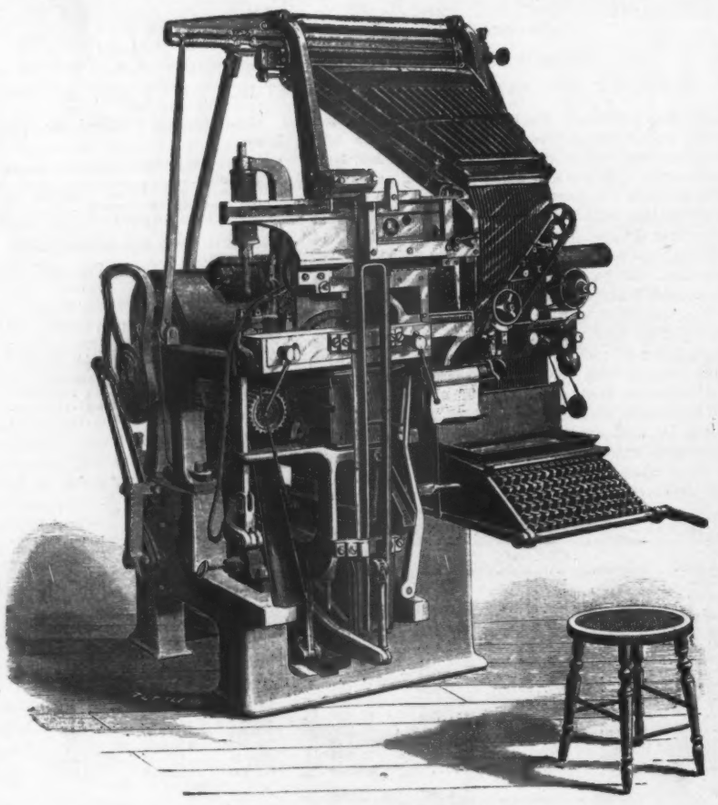


FIG. 3. THE LINOTYPE MACHINE.

type. Ordinary "roman' 'type costs about 45 cts. per lb. A page of type in Engineering News weighs about 35 lbs., hence its 24 pages of reading matter weigh about 840 lbs. To allow for matter held in type, varying use of different sizes of type, and of different letters in a font, at least double this amount would be required to equip a printing office for setting up the 24 reading matter pages of Engineering News, or some 1,200 lbs., representing an investment of about $750. The wooden cases for

haste of newspaper work. It is of course true that time saved means in this case labor saved. The solid "slugs" from the Linotype machine can be made up into solid pages much more rapidly than matter set up in type in the ordinary way.

These practical advantages were sufficient to give the Linotype machine a strong claim to popular favor, provided it could be made a mechanical success; and it is an appreciation of this fact that has sustained the inventor and those associated with him in the arduous and often discouraging work of developing and perfecting the machine, a work which has lasted through no less than 16 years.

Mr. Ottmar Mergenthaler, the inventor of the Linotype machine, was born in Wurtemburg, Germany, in 1854 and came to this country in 1872. A watchmaker by trade, his attention was directed to the subject of composing machinery in the latter part of 1876, while residing in Baltimore, being employed to make some drawings of a composing machine for Mr. James O. Clephane, of Washington, D. C. and Mr. Andrew Devine. Mr. Mergenthaler soon became absorbed in the study of this interesting mechanical problem. From the first his idea was to do away with the use of type, and he tried, but soon discarded the plan of punching a matrix in papier mache which we described two weeks ago. At a later date the idea of forming a matrix in metal and casting from it occurred to him and he set to work on a machine consisting of a series of sliding bars, each bearing on one edge all the characters and spaces. A key mechanism controlled the movement of these bars so as to bring a selected character on one bar in line with a selected character on any other, and thus form the matrix of a complete line for casting. In 1880 a radical change was made and in 1884 the first Linotype machine was completed. Much time was still required, however, to get the machine into working shape, and it was not until July, 1886, that the first machine was set up in the office of the New York Tribune. Even then over a year was spent in the correction of minor defects, and it was not until 1888 that the rapid introduction of the machine began.

But in the evolution of a machine from an inventor's first crude conception there often remain traces of the intermediate stages through which it has passed, especially when the work has been done in a direction wholly untouched by prior inventors. With rare business foresight those in control of the Linotype machine perceived the advantage of giving it a thorough overhauling as soon as its practicability was proved, profiting by the experience gained with machines already in use. The old Linotype machine was described and illustrated in our issue of May 25, 1889. The new machine, a perspective view of which is shown in Fig. 3. discards the air blast and electricity, which were necessary features of the old machine and is in many other respects simpler, and more efficient.

In describing the mechanism of the present Linotype machine, we may note at the outset that the inventor made a great gain when he broke loose from custom and substituted matrices for the types themselves. The matrix (see Fig. 1) is a fair sized piece of sheet brass, which can be handled mechanically with much greater ease and certainty than ordinary type, in setting, in justifying, and in distribution.

The Assembling Mechanism.—These matrices are contained in sloping magazines or channels in the upper part of the machine. Each magazine has room for 22 matrices. Lower case e, the letter most used, has two magazines assigned to it, and there is an automatic attachment to their mouths which causes seven matrices to be drawn from one and then seven from the other alternately.

In most typesetting machines there is a direct mechanical connection between the key and the pusher which ejects a type from a magazine. This is true also of the Linotype; but the machine has also additional features which go a long way toward insuring a positive and correct action. With an operator giving the light touch which is a necessity in very rapid work, there is danger that the key may not be depressed far enough or held long enough to permit the matrix to start out of the magazine. To obviate this the vertical rod connecting the end of the key lever to the matrix discharging mechanism has a projection on it against which a spring roller works. Its action is to resist the upward motion of the rod at the start and afterward to accelerate it. Then if the operator only partially depresses a key, the automatic action completes it. The effect of this automatic action, however, would be to leave the key depressed; so a cam is attached to the vertical rod and when it is raised to its highest point, this cam is brought against a rapidly revolving rubber roller. This revolves the cam and pushes the key and its rod back to their normal position.

Referring to the perspective view of the machine, Fig. 3, the magazines are in the inclined plane at the top of the machine and their mouths are along the line where this plane meets the vertical. The matrices fall from the mouths of the magazines down the vertical channels seen in the perspective view. The left hand channels end close to the point where the matrices are assembled. All the other channels deliver the matrices onto a rapidly running inclined belt. It was an absolute necessity in the design of the machine that the time of transit between the mouths of the magazines and the setting point should be the same for every matrix. An expert operator will often have four or five matrices on their way from the magazine to the assembling point at one time. Evidently these must be brought to the assembling point in the same order in which the keys were struck, or there will be tranposition of letters. Now the speed and inclination of the carrier belt are adjusted to effect this synchronous delivery, and so accurately is this done that a matrix from the farthest magazine on the right reaches the assembling point as soon as one which can drop straight to it. But the spaces are delivered from a magazine on the left hand at a point much closer to the assembling point than the mouths of the matrix magazines. To retard the delivery of the spaces, the channel in which they drop is supplied with a stop lever which is rapidly opened and closed by a cam movement; this effects delay enough to synchronize the movement of the spaces and matrices.

Spacing and Justification.—We have already pointed out that automatic justification, which has proved impracticable with ordinary type, is a comparatively simple process with matrices. In fact, at first glance, it would seem that the use of wedges for spaces, which could be shoved up to extend the line to the full width desired, would meet all requirements. But a wedge working between parallel faces bears only at one point; hence it was

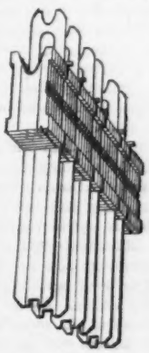


Fig. 5. Line of Matrices Assembled With Space Bands

necessary to use a compound wedge, having its outer faces parallel and its inner faces inclined This compound wedge or "space band," as it is called, is shown in Fig. 4; and Fig. 5 shows a line of matrices with the space bands in place. When the operator approaches the end of the line a bell rings to warn him, and he either divides the last word and puts in a hyphen or ends with a full word according to space. He then moves a lever at the right of the keyboard and the assembled line of matrices is instantly raised about 4 ins. and runs off to the left on the delivery carriage. The operator pays no further attention to this line, but immediately begins setting the next. His movement of the lever has locked a clutch which sets in motion a shaft carrying ten large cams. By mechanism connected with these the assembled line of matrices is justified, alined, and moved down and held in front of the slot which forms the mold. The melting pot is swung up from the rear until its nozzle is in contact with the rear of the mold, and a jet of metal is forced into it. The pot then recedes, the mold recedes a less distance and carries the cast linotype around past a trimming knife which cuts off the "runner" on the foot of the type. Finally it stops and the completed linotype is pushed out by a plunger on a frame beside the one previously completed, receiving a trimming on its two sides at the time. Meanwhile other portions of the machine have attended to distributing the line of matrices from which the cast has been made.

In the perspective view of the machine two slender arms will be seen reaching up to the top of the machine at the left. The right hand one of these swings through the air forward and down and "holds still" while other mechanism places the line of matrices within its grasp. Then it swings up again, taking the matrices, but leaving behind the space bands,, which are promptly swept into the magazine from which they were taken by a laterally moving hook. The matrices elevated by the arm are held in line with the distributing channel and are pushed into it one by one. At the close of this cycle of movements, the clutch on the cam shaft, which drove the mechanism for this complicated series of operations, is unlocked, and no farther movement of this part of the machine occurs until the clutch is again locked by the operator.

We cannot attempt to describe or illustrate in details the complicated and ingenious mechanism by which this great variety of movements is effected. Even the condensed description in the patent office specification occupies 14 pages, and is accompanied by 23 sheets of drawings. Any of our readers who are curious to study these details should procure a copy of the patent of the new Linotype machine (No. 436,532).

We may, however, review briefly some of the points of especial interest in the machine's operation. Fig. 5 shows the line of matrices with the space bands in place. To justify the line a plate is brought up against the lower ends of the space bands and forces them up until the line is wedged out to the full length. Of course its motion is a yielding one, it being actuated by a weight so as to give a constant pressure, whether the space bands are pushed up a short or long distance.

The mechanism for distributing or returning the matrices to their appropriate magazines is of remarkable simplicity. Each matrix contains at the top, a notch with toothed edges (see Fig. 1), a special number or arrangement of teeth being appropriated to each character. A distributor bar extending over the mouths of the magazine channels is provided with horizontal ribs or teeth, varying in number and arrangement over the respective channels. When the matrices are raised by the arm from the casting mechanism, they are presented between two revolving horizontal screws, which engage their edges and cause them to travel successively along the distributor bar, from which they are suspended by their teeth. As each matrix reaches a position over its channel, its teeth disengage from the bar and it falls into its magazine.

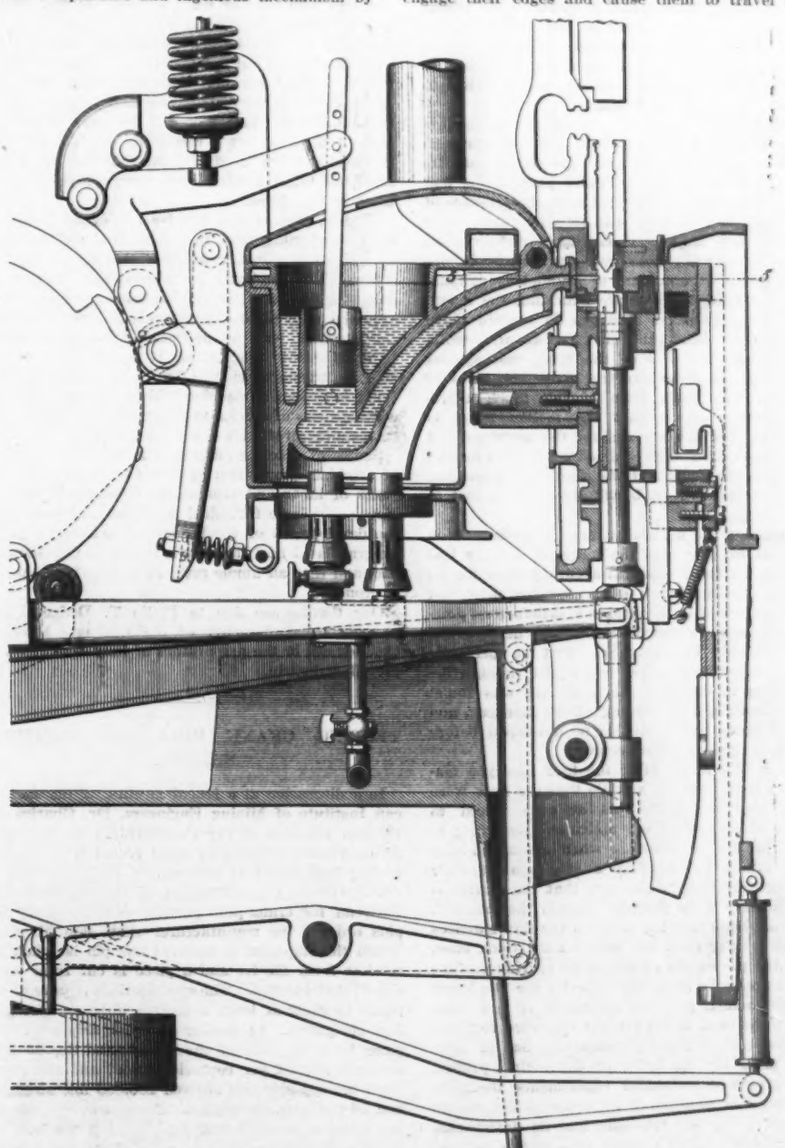


FIG 6. SECTION THROUGH MELTING POT OF LINOTYPE MACHINE.
(Parts in Position for Making Cast.)

Casting the Linotype.—The difficulties in setting, justification and distribution were more easily overcome by Mergenthaler than by inventors of type setting machines; but the problem of casting from the assembled matrices was one which no prior

inventor had met, and unforeseen difficulties were found at every step. In Fig. 6 is shown a section through the melting pot of the Linotype machine with a line of matrices against the front of the mold, and the pot swung up to the rear ready for casting. The metal used is an alloy of lead, antimony and bismuth, which has a moderately low melting point and solidifies very quickly. The outside of the pot is jacketed with asbestos, and between this jacket and the pot the heat from the Bunsen burner circulates, being especially directed around the nozzle of the pot. To secure perfect castings the metal must not be so hot as to take an appreciable time to solidify in the mold; and if it is too cool, it is apt to solidify before the mold is full. To keep the metal at the proper temperature, an automatic mercury governor was attached to the gas jet acting to reduce the flow of gas when the metal is heated too much and vice versa. It was also found necessary to keep the pot away from the mold except when a cast is being made. Otherwise the mold was heated so hot that the cast linotype did not cool fast enough. The pot was at first made to slide to and from the mold, but in the present machine it is pivoted, and is rocked to and from the mold by a cam.

The pump which forces the metal into the mold is of the simplest possible pattern. Its plunger acts also as a slide valve to close the round port between the cylinder and the outer part of the pot. Much trouble was apprehended from the presence of air in the mold, which it was thought might cause blowholes and imperfect castings, and various ways of venting the mold were canvassed. It was even proposed at one time to attempt to exhaust the air from the mold before admitting the metal. But although the cast linotypes do contain blowholes, often of considerable size, they are all found in its body; and the face of the type, cast against the matrices, is absolutely free from blowholes or roughness. The explanation of this much appreciated phenomenon is that the molten metal is squirted in jets directly against the matrices and hardens there first. The confined air collects toward the back of the mold; and while most of it escapes, enough remains to form blowholes near the foot of the linotype.

But leaving the details of the mechanism, it is of interest to note that the machine is little less interesting for its mechanical accuracy than for its ingenuity. As a matter of fact more time and money were spent in developing a satisfactory process of making the matrices than on any detail of the machine itself. The matrices must be perfectly flat, else the molten metal will squirt through between them in casting. Much trouble was found with the bending and warping of the matrices, and a special brass had finally to be developed before satisfactory results were secured.

Again it was found after the first Linotype machine had been used for a while that the lines were crooked, and the fault was at once traced to defective alinement of the matrices. Referring to Fig. 5, the line of matrices when assembled was at first alined by bringing a stop against their upper ears. It is by these ears that the matrix is carried in part of its journey through the machine, and it was found that the wear on the thin matrices had been greater than the wear on the thick ones, (though the proportion of weight to bearing surface was no more). To meet this difficulty the two lower lugs were added, and the alinement is now done against these lugs, which are not subjected to wear. A still more annoying experience was had in making the mold for the letter or the matrix proper. After various unsuccessful experiments the plan was adopted of impressing the letter in the matrix with a steel die, but this plan had its drawbacks. There are hardly half a dozen men in this country who can engrave type dies. They command enormous wages, some $15 per day, and have employers practically at their mercy. Some unpleasant experience with one of these men led those in control of the Linotype machine to look about for some means of relief. An inventor was found in Milwaukee who had done some work on an engraving machine, and he was finally induced to develop it with a view to its use in making the Linotype matrices. Fortunately his efforts were successful and the matrices are now engraved by machine far more perfectly than they could be made by hand.

One more feature of the machine deserves especial mention. It is exceedingly remarkable for its adjustability and its automatic self-protection. For example, the same machine can use matrices for any of the ordinary sizes of type and can cast lines from 1 to 5 ins. in length. Again, if the operator desires several casts of a single line, as sometimes is the case, he simply moves a lever and the machine goes on making cast after cast from the same line of matrices instead of lifting and distributing the matrices as is ordinarily done.

By "self-protection" we refer to the numerous provisions which are made throughout the machine for its automatic stoppage in case of accident. Many years ago one of the popular magazines had a description of a machine for making poetry, which wrecked itself when a visitor to the inventor thoughtlessly dropped a foreign word into it. In very many details the Linotype machine has been so made as to protect itself from injury by the ordinary accidents of daily service. If the casting process should be started with no matrices in the carriage, a movable jaw closes the front of the mold, and instead of a squirt of molten metal the result is a blank bar less than type high. Should a matrix catch in the distributing mechanism, a clutch is instantly detached, stopping this part of the machine until the injury is remedied. In fact provision is made at every needful point that one movement shall not begin until the necessary previous movement is completed.

Finally, the machine has been designed to permit easy overhauling and inspection and quick repair in case of accident, a prime necessity in printing offices. The problem in mechanical designs of attaining this result and at the same time keeping in view the many other requirements in connection with the machine, can be appreciated to some extent by mechanical engineers. It is one thing to design a machine which will "go." It is quite another thing to design a machine which will meet all the contingencies of service satisfactorily, and which can be manufactured with commercial success.

Scores of machines designed to solve the problem of machine composition have had expended on them years of labor and thousands of dollars of money. Those who have furnished the labor and brains for the development of the Linotype machine are to be congratulated that their lot is not to be the common one, and that an ample return for their investments is promised.

Our thanks are due to Philip T. Dodge, Esq., President and Attorney of the Linotype Machine Co., for aid in the preparation of both this and our preceding article.

TESTING CRANK PINS AND FIREBOX SHEETS.

In a discussion at a recent meeting of the American Institute of Mining Engineers, Dr. Charles B. Dudley, Chemist of the Pennsylvania R. R., gave an interesting account of some recent work in the testing department at Altoona.

The standard specifications of the Pennsylvania Railroad for crank-pins provide that for every 50 pins ordered the manufacturer shall ship 51 pins. When the shipment is received one pin is taken at random from the lot and a piece is cut from each side of it and tested. The specifications require these pieces to show at least a certain ultimate strength and elongation. In testing a recent shipment, the piece from one side of the pin showed 88,000 lbs. strength and 22 per cent elongation, and the piece from the opposite side showed 106,000 lbs. strength and 14 per cent. elongation. Each piece was above the specified strength and ductility, but the lack of uniformity between the two sides of the pin was so marked that it was finally determined not to put the lot of 50 pins in use.

To guard against trouble of this sort in future, the specifications are to be amended to require that the difference in ultimate strength of the two specimens shall not be more than 3,000 lbs.

A new specification has been for some time under consideration for firebox sheets, and it is proposed to introduce in it what is called a homogeneity test. Experience shows that with the possible exception of cracks near staybolts, blistering in the principal cause which makes the renewal of fireboxes necessary. The cause of blistering is as follows: In rolling steel plates minute bits of slag or gas bubbles in the material are flattened out and form a break in the continuity of the metal. When the sheet is in use in the firebox, one side is subjected to an intense heat, perhaps 3,000 degrees F., and the other side is kept at not more than 350 degrees to 370 degrees. When the heat in passing through the metal reaches one of these flattened air spaces or flakes of slag, possibly a quarter inch in diameter, it is somewhat obstructed, and consequently the portion of the plate between this spot and the fire becomes hotter than the surrounding metal. This overheated portion expands and lifts up from the metal beneath.

The homogeneity test is merely a nick-bending test slowly made. On bending, the little cavities above referred to open and become plainly visible. Many samples of mild steel which are perfectly satisfactory in strength and ductility, show an abundance of these little openings. So far as is known, this test for boiler plate has never before been used.

Dr. Dudley's description of how the work of compiling the new specification for firebox sheets was set about, is very interesting, especially as it gives a good idea of the system on which the Pennsylvania R. R. compiles its specifications. The first step was to collect samples from about 60 worn-out locomotive boilers whose life was known. One piece from each firebox was tested for ultimate strength and elongation. Then 30 of these pieces were turned over to the laboratory and analyzed for carbon, phosphorus, silicon, manganese, sulphur and copper. It will be understood that the specimens taken represented boilers which had done good service, as well as those which had done poor service.

From the data thus obtained the first draft of the specification was made, and copies were sent to the purchasing agents with the request that they would send it to all the manufacturers of boiler plate from whom they might possibly wish to buy, requesting their criticisms. Copies were also sent to the mechanical officials of the company throughout the road, for their criticisms. When all the information thus obtained was collected, everything was embodied in the specifications that fairly could be in view of the experience on both sides.

As evidence of the care with which the investigation is conducted, Dr. Dudley said that although the new specifications had been under consideration for several months, they had not yet been issued. After a specification is put in force, it is held open to amendment, as difficulties occur in its application. Some of the specifications now in use by the Pennsylvania R. R. have been revised four times since they were originally issued. As an example of the progressive improvement in specifications, in the early days of steel boilers the specification in force called for steel of not less than 50,000 lbs. tensile strength, and not less than 25 per cent. elongation. Some metal was received having 75,000 lbs. tensile strength, and as the elongation was all right it was accepted; but when those plates were being flanged in the boiler shop, they cracked and went to pieces. As a result, an upper limit of 65,000 lbs. tensile strength was established.

That stealing electricity is a misdemeanor in the eyes of the law is the decision of a St. Louis court. A hardware dealer with some knowledge of electricity placed a fine wire across the connections to his meter and caused it to register in a certain time about 320 amperes less than was actually used. When brought to trial his lawyer interposed the ingenious defense that as at common law electricity was unknown, and could not, under the code, be made a subject of larceny, and as no statutory law had been passed making it a felony or misdemeanor to steal electricity, for the reason that its character was not known, and that it was not subject to asportation as personal property, his client could not be convicted of larceny. It was, however, shown by the prosecution that gas, also unknown at common law, was nevertheless something whose larceny was recognized by the law as a misdemeanor. When the attorney for the defense interposed the plea that the act in question was fraud or deception instead of a larceny, the Judge took advantage of the Missouri statute, which makes fraud perpetrated with a view to theft a felony, and set the defendant's bail at $5,000.

TYPHOID FEVER IN CHICAGO.

By William T. Sedgwick (a) and Allen Hazen (b).

Our attention having been drawn to the extraordinary number of deaths from typhoid fever occurring in Chicago, we were led to make an inquiry and to prepare the following paper which is now published for the first time. It was read, in part, in Boston on Jan. 22, 1892, before the American Statistical Association. A postscript has been added.

It does not appear to have been generally recognized that within the last two years, and especially within the last nine months, typhoid fever has been unusually prevalent in the city of Chicago. The fact is, however, that an epidmic of really alarming proportions has prevailed in Chicago within the last year, and the latest returns indicate that that city is still suffering very severely from this formidable disease. Inasmuch as a World's Fair is soon to be opened in Chicago, this unfortunate condition becomes of more than local consequence and should excite grave apprehension. If any remedy exists it ought to be found and applied without delay.

It is especially important that the sanitary condition of Chicago in 1893 should be above reproach, because that of Philadelphia in 1876 was not. At the time of the Centennial Exhibition there was much complaint of the sanitary condition of Philadelphia. Physicians can testify that numerous cases of typhoid fever, which came under their observation in 1876, appeared to be plainly traceable to infection received in Philadelphia. There was apparently ground for suspicion and complaint, for the official report of the Board of Health of Philadelphia for 1876 relates that before the opening of the exposition:

> No little anxiety and solicitude for the health of the city was manifested, since many of the conditions favorable to the propagation of disease were present.

This report also stated that:

> No feature in the mortality records of 1876 is more interesting than the increase in the number of deaths from typhoid fever. There were 773 deaths from this disease, a number which is nearly double the mortality of the previous year (429), and which has not been approached since the year 1865. (c)

By comparing the population of Philadelphia in 1876 with the number of deaths from typhoid fever, we find that the death-rate from this disease for the Centennial year was remarkably high, namely, 9.36 per 10,000 of inhabitants. The percentage of all deaths, due to typhoid fever, was also very high, namely, 4.09. Since 1876 there has been a great increase in the population of Philadelphia, and, therefore, in the annual number of deaths, but the number of deaths from typhoid fever per annum has never been as great as in that year, excepting once, and that only after 12 years, in 1888.

In the city of Chicago there has been for many years a large amount of typhoid fever. It was abundant, for example, in 1872, in 1881, in 1885 and in 1886. Between 1886 and 1890, however, it was less common; but in 1890 the death-rate from typhoid fever suddenly rose to a height almost exactly the same as that reached by Philadelphia in 1876, namely, to 9.16 deaths per 10,000 of inhabitants, and 4.16 per cent. of all deaths which occurred in that year. In other words, typhoid fever prevailed as extensively in Chicago in 1890 as in Philadelphia in 1876. The actual number of deaths in Chicago in 1890 from typhoid fever was 1,008. Remarkable as these figures were they proved to be only the prelude to others still more remarkable, in 1891. During the year just ended Chicago has reported 1,997 deaths from typhoid fever, giving the prodigious death-rate for this disease of 16.64 per 10,000 of population and a percentage of all deaths of 7.19. In the month of May alone there were in Chicago 408 deaths from typhoid fever, or very nearly one-half as many as in the whole state of Massachusetts during the entire twelve months of 1890, and very nearly two-thirds as many as in London, with more than four millions of people, during the whole of the previous year.

In the single month of May, 1891, there were more deaths from typhoid fever in the city of Chicago than in the city of New York during the whole twelve months of either of the years 1888, 1889, 1890 or 1891. In 1891 there were 385 more deaths from typhoid fever in Chicago than were reported by the State Board of Health for the previous year in the whole state of New York, with five times the population; and nearly 1400 more deaths than in London, with three and one-half times the population of Chicago.

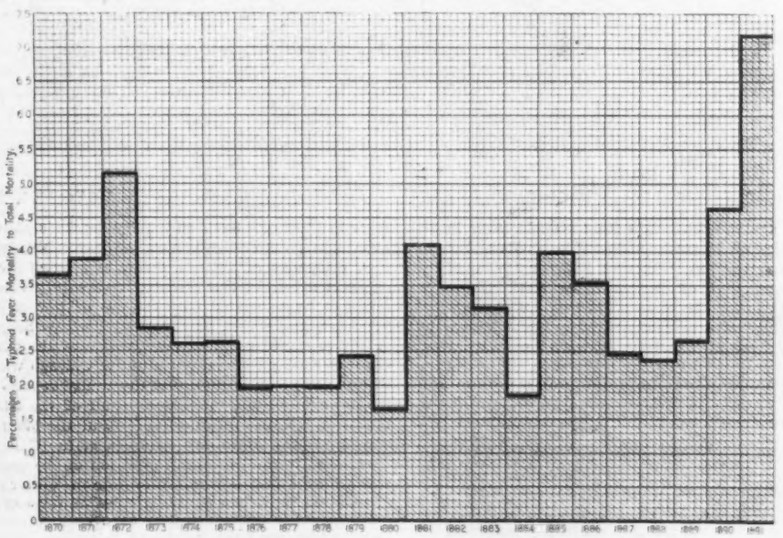


FIG. 1. TYPHOID FEVER IN CHICAGO, 1870 TO 1891.

In this connection the following table, which gives the populations and the number of deaths from typhoid fever in the cities and states named, is instructive:

	Population. (in round numbers).	Deaths from typhoid fever.
Baltimore, 1891	455,000	140
Boston, 1891	450,000	154
Cincinnati, 1891	300,000	186
New York city, 1888	1,536,000	364
" " " 1889	1,583,000	397
" " " 1890	1,631,000	352
" " " 1891	1,700,000	384
Philadelphia, 1891	1,002,000	684
State of Massachusetts, 1890	2,230,000	835
London, England, 1890	4,421,000	619
State of New York, 1890	6,000,000	1,612
Chicago, 1891	1,200,000	1,997
Baltimore, Boston and Cincinnati, 1891	1,214,000	480

Chicago, with almost exactly the same population, had in 1891 more than four times as many deaths from typhoid fever as Baltimore, Boston and Cincinnati combined.

As has just been stated the whole number of deaths from typhoid fever in Chicago in 1891 was 1,997. If we multiply this number by ten we shall have an approximate estimate of the whole number of persons affected by this disease during the year, namely, about 20,000. This indicates that more than 1½ per cent. of the whole population of Chicago were affected in 1891 by a disease which is classed as "preventable."

It does not seem likely that these extraordinary figures can be surpassed or even maintained in 1892 or 1893, but as an indication of the sanitary condition of Chicago they must be a source of anxiety to its citizens, as they certainly are a menace to the sanitary success of the World's Fair.

We may now turn to an examination of the history of typhoid fever in Chicago. The necessary data are given in Table I., which we have compiled from the official reports of the Department of Health of the city of Chicago:

TABLE I.—Typhoid fever in Chicago, 1851-91.

(Based upon statistics published in the annual reports and bulletins of the Department of Health of the city of Chicago.)

			Typhoid fever.		
Years.	Population.	Deaths from all causes.	Total.	Per cent. of all deaths.	Per 10,000 inhb.
1851	34,000	927	10	1.08	2.94
1852	38,734	1,809	48	2.65	12.39
1853	59,130	1,325	35	2.65	5.92
1854	65,872	4,217	86	2.04	13.05
1855	80,023	2,181	43	1.97	5.37
1856	84,000	2,086	66	3.16	7.86
1857	93,000	2,414	82	3.40	8.82
1858	84,000	2,225	49	2.20	5.83
1859	94,000	2,008	51	2.54	5.42
1860	109,260	2,264	46	2.03	4.21
1861	120,000	2,279	74	3.25	6.16
1862	137,089	2,835	85	3.00	6.20
1863	150,000	3,875	140	3.85	9.93
1864	161,288	4,448	192	4.31	11.90
1865	178,402	5,663	190	5.19	10.64
1866	200,418	5,931	203	3.42	10,12
1867	225,000	4,648	165	3.55	7.34
1868	252,054	5,884	200	3.40	7.39
1869	280,000	6,448	183	2.82	6.54
1870	298,000	7,323	268	3.66	9.00
1871	334,270	6,976	272	3.90	8.14
1872	367,396	10,156	524	5.16	14.26
1873	380,000	9,557	272	2.85	7.15
1874	395,000	8,075	211	2.61	5.34
1875	407,000	7,890	207	2.62	5.09
1876	420,000	8,573	168	1.96	4.00
1877	439,776	8,026	159	1.98	3.61
1878	450,000	7,422	146	1.97	3.24
1879	475,000	8,614	208	2.41	4.38
1880	503,298	10,462	171	1.63	3.40
1881	540,000	13,874	568	4.10	10.52
1882	560,639	13,234	462	3.49	8.24
1883	580,000	11,555	361	3.12	6.22
1884	630,000	12,471	354	2.84	5.62
1885	695,000	12,474	405	3.98	7.46
1886	704,000	13,589	483	3.52	6.86
1887	760,000	15,409	381	2.47	5.01
1888	830,000	15,772	375	2.38	4.52
1889	830,000 / 1,100,000*	16,946	453	2.67	4.70
1890	1,200,000	21,869	1,008	4.61	8.40
1891	1,200,000	27,754	1,997	7.19	16.64

* Large territory annexed in 1889.

It is easy to see from this table and the diagram, Fig. 1, that typhoid fever was exceedingly abundant in Chicago in 1872. We cannot agree with the author of the statement in the annual report for 1872, that, although the overcrowding and barrack life incident to the months following the great fire (in October, 1871), "brought its legitimate result, an increased death-rate, during the year no epidemic existed." The fact is, that in that year the death-rate from this disease, and its percentage of mortality to the total mortality were greater than they have ever been since that time, until the present epidemic had developed.

After 1872 there was a marked improvement until 1879, when there was a slight increase, followed by a great increase in 1881. The fever then slowly subsided until 1885, in which year there was another marked increase, followed by a decline in 1886, 1887 and 1888. In 1889 a rise began which attained the proportions of an epidemic in 1890, and reached the great height already referred to, in 1891. It will be noticed that the epidemic of 1872 fell off very rapidly in 1873. That of 1881 declined much more slowly; that of 1885 slowly, also, so that, unless some special effort is made to hasten the decline of the present epidemic, there is reason to fear that typhoid fever may continue to be prevalent in Chicago in 1892 and 1893.

In the next place, we may inquire whether typhoid fever has been on the whole increasing or decreasing in Chicago. An examination of the diagram, Fig. 1, will show that for the eleven years, 1881 to 1891, it has been much higher than for the preceding eleven years; and even omitting 1891, it is plain that typhoid fever has, on the whole, gained ground in Chicago since 1880. This is true even if

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(a) Professor of Biology, Massachusetts Institute of Technology, Boston. (b) Chemist in Charge, Lawrence Experiment Station, Lawrence, Mass.

(c) The number for this year in the summaries given in the report for 1890 is 761, instead of 773.

both 1890 and 1891 are omitted, as the following figures witness:

Periods.	Number of years.	Av. per cent. of typhoid to total mortality.
1870-1880	11	2.79
1881-1891	11	3.67
1871-1880	10	2.71
1881-1890	10	3.32
1872-1880	9	2.73
1881-1889	9	3.17
Av. for the whole 22 years		3.23

These results are confirmed by the averages of the death-rates from typhoid fever for every 10,000 of inhabitants during the same periods:

Periods.	Number of years.	Av. death-rate from typhoid fever.
1870-1880	11	6.15
1881-1891	11	7.66
1871-1880	10	5.86
1881-1890	10	6.75
1872-1880	9	4.62
1881-1889	9	5.61

Av. death rate from typhoid fever for the 22 years, 6.90

The conclusion is inevitable that typhoid fever has on the whole materially increased in Chicago since 1880.

We may next inquire how Chicago compares with other cities in respect to mortality from typhoid fever. Here we naturally turn first to the larger American cities and consider their death-rates and mortality percentages from typhoid fever. We may begin with New York. Table II., for New York, is strictly comparable with Table I., given above, for Chicago, except that it does not go back beyond 1870. Table III. gives similar data for Philadelphia.

TABLE II.—Typhoid fever in New York, 1870-91.
(Based upon statistics published in the annual reports of the Department of Health of the city of New York.)

Years.	Population.	Deaths from all causes.	Typhoid fever. Total.	Per cent. of all deaths.	Per 10,000 inhab.
1870.....	943,300	27,175	422	1.55	4.47
1871.....	955,921	26,976	251	0.93	2.62
1872.....	968,710	32,647	386	1.18	3.98
1873.....	981,671	29,084	313	1.07	3.19
1874.....	1,030,607	28,727	505	1.06	2.96
1875.....	1,044,396	30,709	576	1.22	3.69
1876.....	1,075,532	29,152	325	1.11	3.02
1877.....	1,107,597	26,203	343	1.31	3.10
1878.....	1,140,617	27,008	321	1.19	2.81
1879.....	1,174,621	28,342	268	0.94	2.28
1880.....	1,209,268	31,937	372	1.16	3.08
1881.....	1,246,011	38,624	594	1.54	4.77
1882.....	1,283,870	37,924	516	1.36	4.02
1883.....	1,322,889	34,011	625	1.84	4.72
1884.....	1,363,075	35,034	476	1.36	3.49
1885.....	1,404,401	35,082	405	1.13	2.88
1886.....	1,447,166	37,351	433	1.16	2.99
1887.....	1,491,137	38,933	421	1.08	2.82
1888.....	1,536,444	40,175	364	0.90	2.37
1889.....	1,583,120	39,679	397	1.00	2.51
1890.....	1,631,232	40,103	352	0.88	2.16
1891.....	1,700,000	43,634	384	0.88	2.26

TABLE III.—Typhoid fever in Phila., 1870-91.
(Based upon statistics published in the annual reports of Department of Health of the City of Philadelphia.)

Years.	Population.	Deaths from all causes.	Typhoid fever. Total.	Per cent. of all deaths.	Per 10,000 inhab.
1870.....	674,022	15,317	409	2.67	6.06
1871.....	700,000	15,485	313	2.02	4.47
1872.....	725,000	18,087	369	1.94	5.09
1873.....	750,000	15,224	364	2.39	4.85
1874.....	775,000	15,238	461	3.02	5.95
1875.....	800,000	17,805	420	2.36	5.25
1876.....	825,594	18,892	761	4.03	9.22
1877.....	850,856	16,004	542	3.39	6.37
1878.....	876,118	15,743	404	2.57	4.61
1879(a)....	901,380	15,473	344	2.22	3.82
1880(a)....	846,980	17,711	498	2.81	5.88
1881(a)....	868,000	19,515	654	3.30	7.43
1882(a)....	886,539	20,059	650	3.24	7.33
1883.....	907,041	20,076	579	2.88	6.38
1884.....	927,995	19,999	662	3.31	7.13
1885.....	949,432	21,302	610	2.85	6.42
1886.....	971,363	20,905	618	3.09	6.36
1887.....	993,801	21,719	621	2.86	6.25
1888.....1,016,758		20,372	785	3.85	7.72
1889.....1,040,245		20,536	736	3.59	7.07
1890.....1,046,964		21,732	666	3.07	6.36
1891.....1,092,108		23,307	684	2.93	6.27

(a) These discrepancies in population also appear in the Report of the Philadelphia Board of Health for 1890, p. 154.—Ed.)

The averages computed from Tables II. and III. for New York and Philadelphia may be compared with those for Chicago as follows:

Periods.	Number of years in each period.	Average death-rate from typhoid fever per 10,000 inhab.	Average per cent. of deaths due to typhoid fever.
New York..... 1870-1891	22	3.19	1.17
Philadelphia... " "	"	6.20	2.93
Chicago..... " "	"	6.90	3.23
New York..... 1870-1889	20	3.28	1.20
Philadelphia... " "	"	6.18	2.92
Chicago..... " "	"	5.88	2.69
New York..... 1880-1889	10	3.36	1.25
Philadelphia... " "	"	6.80	3.18
Chicago..... " "	"	6.25	3.02

From this it appears that from 1870 to 1889 typhoid fever was somewhat more abundant in Philadelphia than in Chicago; but that within the last two years the excess in Chicago has been enough to place it at the head even if the period taken be 1870-1891. It must be admitted, however, that the figures for Philadelphia and Chicago are on the whole strikingly similar. The same facts are well shown upon the diagram, Fig. 2.

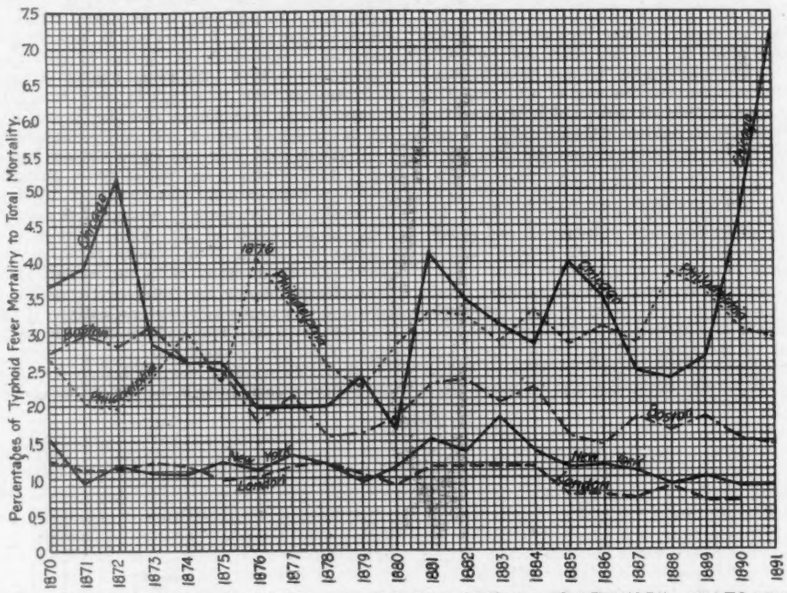

FIG. 2. TYPHOID FEVER IN CHICAGO, PHILADELPHIA, BOSTON AND NEW YORK, 1870 TO 1891.

The average death-rate from typhoid fever in all the cities of Massachusetts, 28 in number, for the 12 years, 1878 to 1889, was 4.62 per 10,000 of inhabitants, that of Boston being 4.32. Chicago's average during the same years was 5.85.

The mortality percentages from typhoid fever in Boston from 1870 to 1891 are as follows:

Years.	P. c.	Years.	P. c.
1870	2.75	1881	2.29
1871	2.99	1882	2.35
1872	2.83	1883	2.03
1873	3.00	1884	2.24
1874	2.60	1885	1.58
1875	2.50	1886	1.45
1876	1.76	1887	1.81
1877	2.13	1888	1.66
1878	1.57	1889	1.81
1879	1.60	1890	1.52
1880	1.80	1891	1.46

The average mortality percentage from typhoid fever in Boston for the 22 years, 1870 to 1891, is 2.08. That of Chicago has already been given as 3.23. The relative prevalence and the history of the disease in the two cities is strikingly shown by the diagram, Fig. 2.

Turning to foreign cities, we may compare the following German cities with Chicago:

Cities.	Population. 1889.	Death-rate from typhoid fever. per 10,000 inhab. 1889.	1878-1888.
1. Dresden	264,196	0.8	1.7
2. Leipzig	213,240	1.7	2.1
3. Munich	284,886	1.1	3.2
4. Cologne	261,105	1.6	2.3
5. Breslau	318,797	1.2	2.9
All five	1,342,224	1.3	2.4
Hamburg	510,646	4.3	3.9
Berlin	1,453,571	2.0	3.1
Chicago	830,000 to 1,100,000	4.7	6.1
Chicago, 1891	1,200,000	16.64	7.19

For typhoid fever death-rate per 10,000 of inhabitants, Chicago and New York compare with London as follows:

London, 1881-1890	1.80
New York City, 1881-1890	3.27
Chicago, 1881-1890	6.75
London, 1891	1.40
New York City, 1891	2.26
Chicago, 1891	16.64

From all the foregoing facts it is evident that typhoid fever has been for many years excessive in Chicago. We have already shown that it is, on the whole, increasing, and within the last two years it has risen to extraordinary proportions. In order to avoid misapprehension it ought to be stated that the total "death-rate" of Chicago, as that term is best known and most often used, is not excessive. Chicago has had, since 1881, fewer total deaths in proportion to its population than New York, and a much lower general death-rate. In respect to typhoid fever, however, the case is exactly reversed.

It is not the principal purpose of this paper to inquire into the causes of the prevalence of typhoid fever in Chicago. Such an inquiry demands patient and thorough investigation on the spot. Nevertheless, epidemics of typhoid fever, and especially a constant excess of this disease, have so often been found to be associated with the use of sewage-polluted drinking water, that we may perhaps be permitted to consider briefly the question of the possibility of such a contamination of the Chicago water supply. We find, in fact, that the annual reports of the Chicago Department of Health and of the State Board of Health of Illinois testify, in the plainest manner, to the unsanitary condition of the Chicago River and to the occasional pollution of the public water supply with sewage. We quote the following:

In Chicago we have a river only one-sixth the average width of the Thames, but with an average depth of 13 ft., which, from one year's end to another, seldom varies 2 ft. upon the average, and ordinarily not one. We have no tide and usually a very feeble current, which, owing to the effect of winds on the lake, is quite often reversed. (a)

The first sanitary regulation made by the authorities of the town (of Chicago was directed to the condition of this river and was) on Nov. 7, 1833, when the Town Trustees declared it to be unlawful to "throw or put into the Chicago River, within the limits of the town, any carcass of any dead animal or animals, under a penalty of three dollars for each offense." It would appear from this, that even at that early date, our sluggish stream demanded legislation to prevent it from becoming a dangerous public nuisance. (b)

In 1840, the public water supply was formally introduced. Prior to this time the inhabitants were dependent for their water supply upon wells and "water carts" that distributed lake water. (c)

In 1861 steps were taken to cleanse the Chicago River by pumping its water into the Illinois and Michigan Canal.

We quote further:

In the winter of 1861-2 the river was very offensive. The spring freshet of 1862 thoroughly cleansed it, at the same time, however, rendering the water that was used for drinking purposes very bad for three or four days, and there was a recurrence of this several times during the year. Although the water had been affected before, but not in so marked a manner, the fact called special attention to the river, and the neces-

(a) E. S. Chesbrough, C. E., in report on Chicago Sewerage, 1858, quoted in Sanitary History of Chicago, p. 278. Published by the Board of Health of the city of Chicago, 1871.
(b) Sanitary History of Chicago, p. 10, Chicago, 1871.
(c) Ibid., p. 15.

sity for obtaining a purer and better supply of water for the city."

In the summer of 1862, Prof. Mahla, employed by the city to ascertain the cause of the black appearance of the river, came to the following conclusions:

. . . At the breaking up of the ice in the river by the spring freshet, all the offensive water was discharged into the lake, leaving the river comparatively pure." . . .

. . . As the amount of cattle and hogs to be killed here during the winter was known to be greater than ever before, it was with great reason feared that the condition of the river and of our drinking water would be more intolerable than ever; but soon after this threatening state of things commenced, the season became unusually mild and rainy, and has continued so ever since. . . .

. . . Owing to these causes, we had not had such exemption from offensiveness in the river and in drinking water for several years as we have had this winter. (c)

In 1862 the Common Council requested the Board of Public Works to report upon the "impure and unhealthy condition of the public water supply," and $10,000 were appropriated to pay for pumping at Bridgeport in order to cleanse the Chicago River, while the Mayor and the Board of Public Works were urged to protect the purity of the river. In 1863 it was proposed to purify the south branch of the Chicago River by turning in the water of the Calumet feeder. The South Branch is described in the report for 1863 as three miles of unspeakable filth. In 1864 it is said that "the sanitary condition of the city was daily growing worse instead of better."

In March, 1867, water was first brought through the lake tunnel, and this is characterized as the "most important sanitary event for several years." It was accompanied, according to Dr. Rauch, by a marked improvement in the public health. (a)

Much relief seems to have been felt for many years, for in 1879 Dr. Rauch writes of:

Our magnificent system of water supply, which has grown with our needs and necessities; and it is not presumptuous to say that at this time the supply of water is as great and good as that of any large city in the world. (d)

From 1883, however, there was evidently renewed anxiety concerning the occasional pollution of the water supply by sewage, for in the report of the State Board of Health for that year we find the following:

If the (Bridgeport) pumps will furnish, and the canal carry off, the volume of water which would result from the adequate dilution of the sewage of the south Branch of the Chicago River, this will relieve the communities along the canal of the nuisance and menace to health caused every winter by the diminished flow and consequent concentration of the contents of the canal; it will keep the main river and South Branch in a practically good sanitary condition; and it will prevent the usual spring pollution of the Chicago water supply, which results from the washing out of the winter's accumulation of sewage, by the spring thaws and rains, into the lowered lake level which obtains this season, and which favors the flow of the sewage out toward the crib. (e)

. . . It is beyond question that the sewage of about 70,000 persons is daily poured into the lake from Chicago, Lake View and Hyde Park. (f)

The sewage of fully 400,000 additional population for at least 40 days in August, September and November, 1885, was also emptied into Lake Michigan. Twice during this period the indescribable filth of the South Fork was swept into the same source of water supply, and during a portion of the time the contents of the North Branch were pumped through the Fullerton Ave. conduit into this general receptacle and fountain. (g)

A systematic observation of the varying character of the water supply of Chicago was begun early in September, under direction of the board. The chemical examinations by Prof. Long are made weekly, and coupled with the meteorological conditions, recorded and furnished by the U. S. Signal Service for this purpose, will result in a scientific determination of the relation of the purity of the water supply to the movement of the sewage contents of the Chicago River. The data already obtained are sufficiently instructive, and the effect of an outward current from the river is plainly seen in the increased quantity of organic matter found in the water drawn from the hydrant in the laboratory. . . .

The removal of 50,000 cu. ft. (of sewage by Bridgeport pumps) per minute, as a minimum is an essential at the present time to the purity of the water supply, and consequently to the health of Chicago. . . . (h)

In this year (1885) also, a committee of the Citizens' Association reported upon the Main Drainage and Water Supply of Chicago, and the following extracts are taken from their report:

The sanitary history of Chicago is a history of makeshifts and expedients. . . .

In the great rain of August 2, of this year, (1885) the contents of both branches of the Chicago River, with the sewage accumulation of many weeks in the South Fork, the contents of slips, and the flushings from several hundred miles of low grade sewers, were, in a few hours, incontinently belched into the lake. At every considerable freshet in the Desplaines and in the North Branch, or several times in an average season a similar obnoxious flood, differing little in degree, is turned lakeward. At other times the flow from the Desplaines is quite sufficient to supply the canal, and the South Branch is left in a stagnant condition of accumulating putridity, ready to take its way to the lake on slight occasion. Your committee found the South Branch in bad condition a week after the great storm, and within ten days the South Fork was pestilential—a seething, bubbling mass of decomposition, exhaling the most noisome odors.

The ejection of such volumes of sewage into the Lake at irregular intervals, is a matter for most serious consideration in connection with the water supply. That it sometimes reaches the crib under favoring conditions of wind and current, is a matter of direct observation, and evidence from city hydrants. That it sometimes extends southward to the Hyde Park supply is also ascertained. Even the comparatively small discharge from the Fullerton Ave. conduit has given evidence of pollution when no other sewage was entering the lake. Recently the discharge from this conduit was observed in an unbroken stream for over a mile south, and parallel to the shore, and again in a similar position to the north, to the well-grounded alarm of the people of Lake View. That raw unoxidized sewage occasionally and not rarely contaminates our drinking water, does not admit of serious question. On Wednesday, August 5, the river discharge was observed in an unbroken stream to and around the crib. Chemical and microscopical examinations of the water collected under different conditions are appended to the supplementary report.

. . . It is foreign to the purpose of this report to review the Bridgeport pumping works. Suffice it to say that, although they have been several times altered by their builders, they yet fail to attain the specified capacity and duty, and further alteration is understood to be contemplated. . . .

This testimony amply confirms the belief that the source of the Chicago water supply, Lake Michigan, in its natural condition is such as should satisfy the most captious, and that no alarm need be felt for the ultimate satisfactory solution of the water question, except through neglect or incapacity. Your committee is, however, unanimous and unqualified in stating that, under existing circumstances, the water supply is frequently, and for considerable periods of time, dangerously contaminated. That the river water and sewage have, on several different occasions since the second day of August last (1885) reached the crib in an unbroken flow, admits of no possible doubt.

River water and sewage in a partially diluted state have surrounded the crib during nearly the entire time covered by the investigations of your committee." (i)

For the following year, 1886, the conditions were thus described by the Illinois State Board of Health:

In a general way it may be again stated that the purity of the drinking water drawn through the lake tunnel is affected by the discharge from the Chicago River into the lake, whether this be caused by a lower lake level, by an overflow from the Desplaines River, the drainage of the territory adjoining, or by failure to operate the Bridgeport pumps.

During the winter months this result is complicated by the extension of ice from the shore, retarding oxidation; by thaws of large quantities of polluted snow; and by the diminished flow through the canal, caused by ice obstruction. . . .

As nearly as I can ascertain, the average amount of water pumped daily is only about 35,000 cu. ft. per minute. At this time it should be from 45,000 to 50,000.

It is unfortunate both for the sanitary interests of Chicago and the country along the canal, that the pumps have not the capacity they were contracted for, and it is to be hoped that they will be placed in condition to do what is required with as little delay as possible. This is specially important, as the probabilities are that a great amount of rain will fall the next six months to make up for the small amount that fell during the past six months, and that during this time the water will again become polluted. . . .

These fluctuations (of the lake) play a very important part, as affecting both the character of the water supply and the condition of the river. For example, the fall from 11 ft. 5 ins. on June 1, to 10 ft. on the 3d, 4th and 5th, resulted in the discharge into the river of an immense volume of foulness from the South Fork and the slips and docks, where it had been pent up while the lake was high. . . .

The observations of these four months demonstrate that the sewage of Chicago can be prevented from polluting its water supply, and that when this is done, the city has the best supply, all things taken into consideration, of any large city on the continent, if not in the world. (j)

In 1887 a Board of Experts constituting a Drainage and Water Supply Commission, published a preliminary report, from which we take the following:

The examination disclosed the fact that the city is sometimes greatly suffering from the offensive conditions of parts of the Chicago River and its branches, caused by the discharge of sewage into the same, and from the occasional contamination of its water supply, brought about by the discharge of the polluted contents of the river into the lake. It also disclosed the fact that almost every conceivable way of dealing with these questions had been suggested, and in some forms applied during the past 30 years.

The problem, therefore, demands the attainment of two ends: The protection of the water supply and the removal of the river nuisance. . . .

As the water must be taken from the lake, it is evident that both its pollution and the objectionable condition of the rivers should be prevented by a better disposition of the sewage. The effect of this condition of the river is to endanger the purity of the water supply whenever the river, with its accumulated deposits, flows into the lake, which occurs when the rain water that finds its way into the river, exceeds the amount pumped into the canal. If this excess is great, as in the spring, and occasionally in the summer months, the contamination of the lake is considerable, and must constantly increase. (k)

As late as 1891, we read:

When the Bridgeport pumps are operated to half capacity, as has happened much of the time in the last few years, they scarcely remove the volume contributed from the water supply through the sewers and by the Fullerton Ave. conduit, and the normal land drainage, and much sewage finds its way into the lake, in addition to the 200,000 people directly tributary. In storms the flow is, of course, lakeward. . . . (l)

It appears from these authoritative statements that the water of Lake Michigan is regularly polluted in the vicinity of Chicago by the raw sewage of a considerable population, and occasionally, by the flushing of the Chicago River. This condition is of long standing, but has plainly grown worse in recent years. There is also abundant evidence of the actual pollution of the water supply by sewage, so that it seems probably that the constant excess of typhoid fever in Chicago since 1870; its gradual increase, and its extraordinary abundance in 1891 will be proved to have proceeded chiefly from this cause. It is gratifying to learn that an earnest endeavor is being made to remedy the pollution of the Chicago water supply. The new four-mile tunnel is approaching completion and the intake, being further out, will afford considerable relief. If the Bridgeport pumps are also improved and faithfully worked to their full capacity, still further relief may be expected.

Postscript, April 15, 1892.

A report giving in substance the above facts appeared in a prominent Chicago newspaper (the "Tribune") on Jan. 22, 1892. The attention of the authorities was thus drawn to the subject, and, after some demur, the report appears to have been accepted as a fair statement of the facts. It appears to be generally admitted that the pub-

(c) Sanitary History, etc., pp. 281, 282, 283.
(a) Sanitary History of Chicago, pp. 114, 167.
(d) Sanitary Problems of Chicago, 1879, p. 8; second annual report State Board of Health of Illinois, p. 101.
(e) State Board of Health of Illinois, vi., (1883) p. 78.
(f) (Lake View and Hyde Park were annexed to Chicago in 1889.—Ed.)
(g) State Board of Health of Illinois, viii, (1885) CXXVII.
(h) State Board of Health of Illinois, viii., (1885), p. lxix.
(i) Report of the Committee of the Citizens' Association on the Main Drainage and Water Supply of Chicago, 1885, pp. 1, 4, 8, 18.
(j) Ninth Annual Report, State Board of Health of Illinois; pp. xiii., xxx., xlv., xlvi., 1886.
(k) Preliminary Report, Drainage and Water Supply Commission, pp. 14 and 18, 1887.
(l) The Lakes and Gulf Waterway as Related to the Chicago Sanitary Problem. A Preliminary Report, by L. E. Cooley, C. E.; p. vi., May, 1891.

lic water supply has been in the past, and is now, seriously polluted with sewage. According to the newspapers the water from some of the intakes has been pronounced to be plainly polluted and unfit for drinking, while chemical and bacterial analyses are said to have revealed the presence of sewage in the drinking water. Nearly three months have now gone by since public attention was drawn to the subject, and at least one prominent newspaper alleges that little has yet been done about it. Meantime, however, the four-mile tunnel is being rapidly pushed forward, and, in spite of possible defects in its construction, it is hoped that it will be ready for use in the autumn. It has been positively stated that the cause of the enormous excess of typhoid fever in May, 1891, was the total stoppage of the Bridgeport pumps which should lift the sewage from the Chicago River and cause it to flow toward the Mississippi, allowing it instead to flow directly into Lake Michigan. It is therefore gratifying to learn that a drainage canal has been located; that the pumps are being renovated, and that strenuous efforts appear to be making to remedy the present state of things. (a) The urgent need of haste is shown by the fact that for the month in which this paper was read (January, 1892) the number of deaths (311), from typhoid fever, was greater than that in any previous month except May, 1891. Since that time the epidemic appears to have declined.

THE MONTE SAN SALVATORE CABLE RAILWAY.

A cable railway of peculiar and bold construction was built in 1889-90 up the precipitous shore of Monte San Salvatore, at Lugano, Italy, the following description of which we abstract from the "Schweizerische Bauzeitung." From the initial station at the foot of the mountain the track runs in a

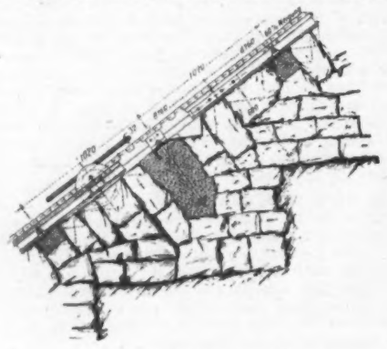

Fig. 1. Longitudinal Section.

straight line, bridging the Gotthard Railway and the valley of the Calprino, up to a midway station. From there the upper section after passing a short reversed curve runs into a straight line to the terminus at the top of the mountain. The difference in elevation overcome is 1,973 ft., the total length of the line being 5,358 ft., or 4,944 ft. horizontally. The line starts with a grade of 17 per cent., and gradually attains 38 per cent. at the middle station. Pezello. The upper section commences with 38 per cent. and terminates with a grade of 60 per cent.

The railway has a gage of 1 meter (3.28 ft.). It is a single track, so that only one car traverses each of the two sections, the arrangement being that when the lower car is going up the upper car is coming down, or vice versa. A fixed motor placed at the middle station supplies motive power to the driving drums, and consequently to the cable connected with each car, which runs around a pulley at the upper terminus. By this arrangement the cars can be placed alongside each other at the midway station, permitting the passengers to change cars conveniently.

The track of this road rests upon a bed of solid masonry, which is carefully built into horizontal steps cut from the rock slope at Monte San Salvatore (Fig. 1). The ties are 5 ft. 11 ins. long and weigh 30.24 lbs. per yard. They consist of angle bars with flanges of unequal width, of which the narrower one is let into a bed of concrete. They are laid 47 ins., c. to c. To provide against any movement of the track downward, two ties per rail length are anchored in a bed of concrete by 20-in. bolts.

The rails used are 30 ft. in length, weighing 35½ lbs. per yard each. They are fastened to the ties by short bolts and clamps. At the upper tie under each rail the clamp is extended under the head of the rail and bolted to the web, forming a check plate to prevent creeping. The rack, which is centrally located, is of the Abt type. It is used only for braking purposes. At the sides of the masonry foundation paved gutters (Fig. 2) are constructed. From where the grade attains 28 per cent. continuous stone steps are placed beside the track. The cars used have four half-open compartments, with eight seats each. The floor of the car on the lower section stands horizontal at a grade of 28 per cent., while the one of the car on the upper section stands level at 50 per cent. rise. The frame is composed of two longitudinal girders of channel bars, with suitable transverse bracing. Inside of it a lighter frame is provided to carry the brake mechanism. Each car is furnished with a hand and automatic brake, working independently from each other. Both brake systems can be handled on either platform. Each of the two axles carries two steel pinions.

The continuous cable used is 9-32-in. diameter, weighing 7 lbs. per yard. The working strain on the cable amounts to 5.3 tonnes. Its ultimate strength was shown by test to be 53.5 tonnes, and its elongation for 1 meter (3.28 ft.) equal to 1 1-5 ins.

At the middle station the cable leads from the lower car directly to the driving drum of 13 ft. diameter, and passes to the 10-ft. drum opposite. From here it returns to the former, which it again half encircles, to lead back to the second drum again. Then it is finally run to the upper section, passing around a wheel of 11.5 ft. diameter at the upper terminus, to connect with the car running on this part of the railway. The pulleys over which the cables runs are placed from 39 to 46 ft. apart. They consist of two round cast iron plates, with hardwood filling (Fig. 2). Wood filling in pulleys is used here for the first time to lessen the wear on the cable as much as possible.

The maximum speed on this railway is assumed to be 3 ft. per second. The power required is furnished by a stream at Arogna, and is generated by two Girard turbines at Maroggia, whence it is transmitted to the secondary (middle) section by a 3-16-

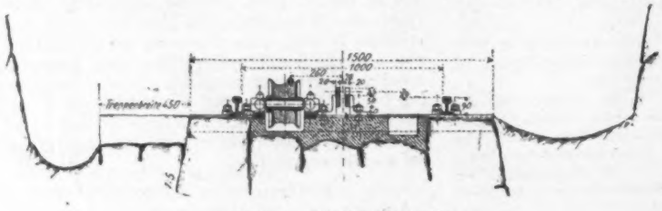

FIG. 2. CROSS SECTION.

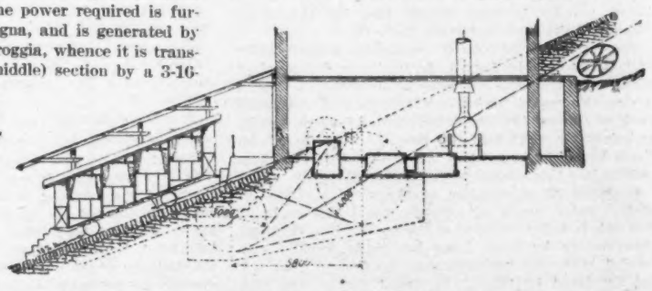

FIG. 3. LONGITUDINAL SECTION THROUGH MIDDLE STATION.

in. copper wire. Beside the secondary dynamo at the middle station, a portable engine of 50 HP. is stationed there to furnish power in cases of disturbances or repairs on the turbine plant or its transmission. The receipts of this line for the first year, with 33,886 passengers, amounted to $10,174, against $4,310 running expenses. The cost of construction was $125,000.

(a) See reference to drainage canal in editorial, "The Chicago Water Supply and Typhoid Fever;" also article, "Improvements to the Chicago Water Supply;" both articles appear in this issue.—Ed.)

The grade crossing question is under consideration at Hull, England. The city wishes to eliminate the crossings of the Northeastern Ry., and the proposed acquisition of the Hull Docks by the railway company presents an opportunity, and the Parliamentary Committee of the corporation is now considering the question. The desired object could only be attained by the construction of a high-level railway, and it is said that the railway company has offered to undertake this work, on the condition that the city subscribes $500,000.

The additional water-works, to supply the city of Paris with the water of the Vigne River have been begun. From the source of that river to the heights of St. Cloud, near Paris, an aqueduct is to be built, supplying a reservoir at St. Cloud, which is also in course of construction. The conduit main leading to the city is to have a diameter of 5 ft. 7 ins., reducing to 4 ft. 11 ins. at its end. The plant is intended to supply 107,560,000 gallons daily. The cost of construction is estimated at $7,000,000.

The Memphis Bridge, across the Mississippi, is to be formally opened on May 12. Some discussion recently took place in the U. S. Senate over the omission to provide a separate wagonway across the bridge. The law authorizing the construction of the bridge stipulated that facilities should be afforded for wagon traffic. It is stated that those in control of the bridge propose to comply with this by opening the bridge to wagon traffic only during certain hours of the day, or else by running a train of ferry cars across the bridge at frequent intervals. The Senate adopted a resolution calling on the Secretary of War to state just what provisions the company proposes to make to comply with the terms of its franchise.

The Assam & Bengal Railway Co. has been incorporated in England, to construct, under the authority of the Secretary of State for India, a system of railways in the provinces of Bengal and Assam, in the eastern part of India. The main line will be 582 miles long, extending northward from the port of Chittagong, on the Bay of Bengal, to a connection with the railway of the Assam Trading Co. There will be three branches aggregating 160 miles, making a total length of 742 miles of railway. Surveys have been made under the orders of the Government of India, and the cost is estimated at about $24,000,000, or about $32,450 per mile, for a single track, meter gage line, including rolling stock. The line will open up a tea-producing country, coal fields, and a petroleum district. Mr. W. Duff Bruce, of London, is consulting engineer.

PERSONALS.

Mr. Marc Eidlitz, a prominent builder of New York, died April 16.

Mr. Thomas C. Cogswell has been appointed Railroad Commissioner of New Hampshire.

Mr. G. W. Vaughn has been appointed Chief Engineer of the Santa Fe, Prescott & Phoenix Ry., now being built in Arizona.

Mr. H. C. Draper, Division Engineer of the Chicago & Alton R. R., has been appointed Chief Engineer, vice the late Mr. K. F. Booth.

Mr. James B. Gass has been re-elected for a third term as City Engineer and Inspector of Plumbing and Sewers, at Fort Smith, Ark.

Mr. Wilford F. Smith, of Plankinton, S. Dak., has been appointed a member of the State Railroad Commission, vice Mr. Frank B. Phillips, resigned.

Mr. J. H. Moulton, of New York, died April 9. He had been engaged as engineer for many railway and mining enterprises in Central and South America.

Mr. Cornelius Shields, General Superintendent of the Chicago, St. Paul & Kansas City Ry., has resigned to become Superintendent of the Western Division of the Great Northern Ry.

Mr. D. C. Dunlap has been appointed Chief Assistant Engineer to the Chicago Drainage Board, at a salary of $3,600. He was at one time Assistant City Engineer, and has also been connected with the Chicago & Northwestern Ry. He was for three years City Engineer of Rockford, Ill.

Mr. Eward DeMille Campbell, Assistant Professor of Metallurgy in the University of Michigan, at Ann Arbor, Mich., has lost the sight of both eyes. He was making an experiment in his laboratory when an explosion occurred, breaking the glass vessel and filling both his eyes with broken glass, destroying the sight.

Mr. M. Riney, of the firm of Riney & Co., Chicago, contractors for erecting structural iron work, etc., has completed his work as Superintendent of Erection of the 264 ft. dome for the Administration Building, at the World's Columbian Exposition, and has been engaged to take charge of the construction of the Third Ave. cable railway in New York. It should be placed to Mr. Riney's credit that no accident occurred during the erection of the dome. A. Gottleib & Co., of Chicago, were the contractors.

Mr. A. M. Mosier, Superintendent of the Chicago & Erie R. R., has returned to his old position of Superintendent of Transportation. As a result of this change the Eastern and Western subdivisions of the road will become divisions of the Erie system, and the Assistant Superintendents will become Superintendents of the respective divisions, reporting direct to Mr. Moorhead, General Superintendent. Mr. C. C. Reynolds will be Superintendent of the Eastern Division, from Marion Junction, O., to Huntington, Ind., with headquarters at Huntington. Mr. G. A. Coe, of Chicago, will be Superintendent of the Western Division, which extends from Huntington to Chicago.

Gen. George Stark, formerly Manager of the Boston & Lowell R. R., and at one time Vice-President and General Manager of the Northern Pacific R. R., died at Nashua, N. H., April 13, at the age of 69. He entered the employ of the Boston & Lowell road in 1836 and participated as an engineer in the construction of the Nashua & Lowell, Concord, Nashua & Wilton, Stony Brook and Concord & Montreal railways, and made surveys for the Central Vermont and Old Colony systems. From 1849 to 1853 he was Assistant Superintendent of the Nashua & Lowell road. He then became Superintendent of the Hudson River road, which office he resigned to become Superintendent of the Boston & Lowell, later being appointed Manager.

Mr. David McNeely Stauffer was married April 19, at St. Paul's Church, Yonkers, to Miss Florence Scribner, daughter of Hon. G. Hilton Scribner, of Yonkers, N. Y. A large reception at Inglehurst, the home of the bride's parents, followed the ceremony. Mr. and Mrs. Stauffer will sail for Europe by the steamer "La Bretagne" on April 23, and will spend about three months in Europe. The marriage is the romantic and pleasing result of the wreck of the steamer "Aguan" on Roncador Reef, a little over a year ago, with the Hon. Warner Miller's party, en route to look over the Nicaragua Canal. Mr. Scribner and his daughter, and Mr. Stauffer were among the members of this party. The story of the wreck and of the escape of the passengers and crew to a scrap of a desert island, eight miles off, whence they were rescued only after many days and much anxiety and exposure, has been in part told in these columns by Mr. Stauffer himself. What he did not tell, and what it is hardly appropriate for us to attempt to tell, was the brave and womanly behavior of a certain young lady, which had unexpected results—at any rate, to those who were not of the party.

NEW PUBLICATIONS.

REPORT OF THE BOARD OF RAILROAD COMMISSIONERS OF THE STATE OF KANSAS, for the Year ending June 30, 1891. Pub. Doc., 8vo., pp. lv. × 319; with map.

All but three pages of the report is taken up with the reports of the several railway companies in the state, and the decisions of the Commission. There is nothing of technical interest. How effective a cure of the mania for new construction has been worked by the over construction of the past five years is shown in the two following sentences quoted from the report: "Less than two miles of road have been constructed in the state during the past year. It is well." It is but fair, however, to say that the Commissioners were as little influenced by the flush times of 1887 as could be expected, and that they counseled moderation and recommended, in 1886, the repeal of the law permitting cities and towns to bond themselves in aid of railway enterprises.

REPORT ON THE ABOLITION OF GRADE CROSSINGS IN THE CITY OF WORCESTER, MASS. 1892.—Charles A. Allen, A. W. Locke and John W. Ellis, Commissioners. 8vo., pp. 92; numerous maps, profiles and illustrations.

The Board of Aldermen passed an order in December, 1890, providing that a commission be appointed, consisting of the city engineer and two other expert engineers, to examine and prepare plans of the grade crossings, to submit plans of proposed changes, and to report upon the best method of having the grade crossings abolished. Different plans for the depression and elevation of the tracks were considered, and the plan recommended provides for the elevation of the railways at a total estimated cost, including all grade crossings in the city, of $2,004,000. The Commissioners wisely recommended that nothing further should be done in abolishing the crossings in the central part of the city until a well defined plan has been fully decided upon and adopted. The Commissioners' plan provides for the elevation of the tracks in the Union Station 8 ft., and the depression of the floor 3 ft. As the station is now used, the people have free access to all the tracks, and, as there are no fences or gates, the subways which are provided are practically unused.

SOCIETY PROCEEDINGS.

CIVIL ENGINEERS' CLUB OF CLEVELAND.—At the meeting on April 12, the paper of the evening was read by Dr. Dayton C. Miller on "Astronomical Spectroscopy." The general theory of spectrum analysis was given, the sun being considered the typical source of energy. The spectroscope in its different forms was described, and its application to the study of solar phenomena explained. Special attention was given to a description of a new universal spectroscope recently made by Brashear for Prof. Young, of Halstead Observatory of Princeton College. This instrument is more complete and perfect than any before constructed; it is adapted for either visual or photographic work. Professor Young has already made some excellent photographs of the spectrum of sun spots, the chromosphere and prominences, fixed stars and planets, which promise brilliant results. Solar investigations at Princeton are to be continued, and the work extended to the study of stellar motion in the line of sight. Mention was made of the very valuable work of Professor Geo. E. Hale, of Chicago, and Professor Vogel, at Potsdam. The paper was illustrated with lantern slides.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—The annual convention will be held at the Hygeia Hotel, Fortress Monroe, Va., beginning June 8. The hotel rate has been fixed at $3.50 per day. Reduced rates for transportation have been applied for, and, together with the details of excursions to be taken and the program of the convention, etc., will be announced at a later date. There are many points of historical interest within easy reach, and arrangements will be made to visit some of them. Members are invited to contribute for presentation at the convention, papers on any topic of professional interest, and to discuss papers already published in the "Transactions." Papers should be in the hands of the Secretary as soon as possible, to insure proper preparation and a satisfactory arrangement of the program. Members intending to send papers should give early notice of such intention. By resolution of the Board of Direction, a bulletin will be issued twice each month, about five days before the semi-monthly meetings. The Board has also appointed Mr. C. W. Hunt Assistant Secretary, and Mr. Thomas B. Lee, Auditor.

AMERICAN RAILROAD ASSOCIATION.—The annual meeting was held in New York, April 13, President H. S. Haines, of the Savannah, Florida & Western Ry., in the chair, and about 80 representatives present. In his opening address President Haines reviewed the progress in the introduction of automatic couplers from the first action by the Master Car Builders' Association in 1874 to the present date, and contrasted with it the action of state legislatures and railroad commissions, showing that practically all of the progress which has been made in the introduction of automatic couplers has been made by the railways themselves without legal compulsion. As an example of the work which the railway commissioners did in the early days of the reform, he instanced the action of the Massachusetts Commission, which in 1885 prescribed five different couplers which would not couple with each other and notified the railway companies that all new cars or cars fitted with new couplers must be equipped with one of the five prescribed. In July, 1888, the Commission reported that only 5,000 cars had been fitted with these officially approved couplers. The Michigan Commissioner in 1886 prescribed seven different kinds of safety couplers, an order which had as little results as that issued in Massachusetts. After remaining a dead letter for some years it was rescinded by the Commissioner in 1890.

Reviewing the laws now before Congress, he said the stumbling block for the framers for all of them has been the difficulty in prescribing the form of safety coupler with the exactness necessary to make a penal statute effective. Some propose to get around this by submitting the matter to a vote of railway employees; but enough information has already been collected to show that employees are more apt to favor the old devices with which they are familiar than they are the safety couplers, which will make unnecessary the dexterity they have acquired in the use of the link and pin.

Another plan is to submit the decision as to what coupler shall be standard to a special commission, which will virtually have to do over again the work which has been done by the Master Car Builders' Association. Should it decide in favor of the M. C. B. type, its decision will be unnecessary, since railways representing 5-7 of the mileage of the country have already adopted it. If they attempt to decide in favor of some other coupler, what other safety coupler can they find which has been fully tested in service, and which can be successfully used in connection with power brakes? In short, the only justification for compulsory legislation is to enforce the adoption of the M. C. B. type by the small minority of railways which have not as yet taken action upon its use. But without legislation, as soon as the railway companies which have urged this reform are themselves in position to insist upon it, they will refuse to receive in interchange any car not fitted with M. C. B. couplers. The car inspector's chalk mark is all the compulsory legislation that will be needed to bring these dilatory companies into line.

The executive committee reported a gratifying increase in the membership and stated that a special session of the association would probably be held in Chicago during the coming summer at the request of the committee on train rules. The committee on train rules reported that the replies received from the circular relative to the 24-hour system of notation had not prepared them to propose any action. The report of the car service committee favored paying freight car services at the rate of ½ ct. per mile and 6 cts. a day, but it was decided to postpone the consideration of this report until the October meeting. The committee on safety appliances reported on the subject of power brakes. The recommendations were approved. President Haines was re-elected. The next meeting will be held in New York next October.

COMING TECHNICAL MEETINGS.

DENVER SOCIETY OF CIVIL ENGINEERS.
April 26. Secy., Geo. H. Angell, Jacobson Block.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
May 2. Secy., C. L. Annan.
ENGINEERS' CLUB OF ST. LOUIS.
May 4. Secy., Arthur Thacher, Odd Fellows' Building.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
May 4. Secy., F. Collingwood, 127 East 23d St., New York.
June 8. Annual Convention, Old Point Comfort, Va.
WESTERN SOCIETY OF ENGINEERS.
May 4. Secy., J. W. Weston, 930 La Salle St., Chicago.
ENGINEERS' CLUB OF MINNEAPOLIS.
May 5. Public Library Bldg. Secy., F. W. Cappelen.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
May 6. Secy., E. K. Smoot, 806 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
May 6. Secy., O. von Geldern, 819 Market St., San Francisco.
SWEDISH ENGINEERS' CLUB.
May 7. Secy., P. Valentine. At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia.
NORTHWEST RAILROAD CLUB.
May 7. Union Station, St. Paul.
ENGINEERS' CLUB OF PHILADELPHIA.
May 7. 1122 Girard St. Secy., J. C. Trautwine.
ENGINEERS' CLUB OF KANSAS CITY.
May 9. Baird Building. Secy., H. Goldmark.
WISCONSIN POLYTECHNIC SOCIETY.
May 9. Loan & Trust Bldg., Milwaukee. Secy., M. Shinke.
ATLANTA SOCIETY OF CIVIL ENGINEERS.
May 10. Secy., Parker N. Black, Capitol Block.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
May 10. Secy., C. S. Howe, Case Library Building.
NORTHWESTERN SOCIETY OF ENGINEERS.
May 10. Occidental Block, Seattle. Secy., E. H. Warner.
NEW ENGLAND RAILROAD CLUB.
May 11. United States Hotel, Boston. Secy., F. M. Curtis.
ENGINEERING ASSOCIATION OF THE SOUTHWEST.
May 12. Secy., O. H. Lundreth, Nashville, Tenn.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
May 12. Secy., Edward Mead, Norton Building.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
May 13. Union Station, St. Paul.
TECHNICAL SOCIETY OF NEW YORK.
May 14. 194 Third Ave. Secy., H. Schretter.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
May 14. At Roanoke. Secy., J. B. Schick, Roanoke, Va.
AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
May 16 to 20. San Francisco, Cal. Secy., F. R. Hutton, 19 W. 31st St., New York.
AMERICAN WATER-WORKS ASSOCIATION.
May 16. Secy., J. H. Decker, East Orange, N. J.
WESTERN RAILWAY CLUB.
May 17. Rookery Building, Chicago. Secy., W. H. Marshall.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
May 17. Secy., R. N. Clark, Pittsburg, Pa.
BOSTON SOCIETY OF CIVIL ENGINEERS.
May 18. Secy., S. E. Tinkham, City Hall.
ENGINEERS' CLUB OF CINCINNATI.
May 19. Secy., J. F. Wilson.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
May 19. Secy., T. G. Philfeldt, 113 Adams St.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
May 19. At Atlanta, Ga. Secy., F. A. Charpiot, Macon, Ga.
NEW YORK RAILROAD CLUB.
May 19. At 12 W. 31st St. Secy., H. G. Prout, 73 Broadway.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
May 19. Secy., C. H. McLeod, Montreal, P. Q.
MONTANA SOCIETY OF CIVIL ENGINEERS.
May 21. Secy., F. D. Jones, Helena.
CENTRAL RAILWAY CLUB OF BUFFALO.
May 25. Secy., Jas. Macbeth.
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 6, 7. Grand Pacific Hotel, Chicago. Secy., R. W. Pope, New York.
NEW ENGLAND WATER-WORKS ASSOCIATION.
June 8, 9, 10. Holyoke, Mass. Secy., R. C. P. Coggeshall, New Bedford, Mass.
AMERICAN RAILWAY MASTER MECHANICS' ASSOC'N.
June 20. Saratoga, N. Y. Secy., A. Sinclair, New York.
AMERICAN INSTITUTE OF MINING ENGINEERS.
June 21. Plattsburg. Secy., R. W. Raymond, New York.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

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D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

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ADVERTISING RATES, 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

Engineering News is, we believe, the first engineering or mechanical journal in the world to discard the old process of type setting by hand, which has endured since the invention of printing, and to adopt machine composition. It is also, so far as we can learn, the pioneer among all illustrated journals in introducing the latest and most improved style of composing machine, the New Linotype, which we risk nothing in saying, deserves to take high rank among the great labor-saving inventions of the present century. According to the latest list, 34 dailies and one weekly (the Catholic News) have preceded it in so doing. The development of this machine has involved some remarkable problems in mechanical engineering, which we have described elsewhere, and examination of which, we believe, will be of interest and profit to engineers generally.

The metropolitan police district of London, or the "Greater London," as will be seen by the interesting summary of London municipal government which appears in another column, includes an area of 15 miles radius from the center of the city, and a population of about five and a half millions. To show what injustice is done to the actual size of metropolitan New York by its subdivision between two states and many different city governments, a circle of similar radius struck from lower New York includes Jersey City, Hoboken, Passaic, Paterson, Newark, "all the Oranges," Elizabeth and other smaller cities, aggregating 712,000 inhabitants. It includes all the northern half of Staten Island, all of Brooklyn and far beyond it into Queens Co., and about half the population (though much less than half the area) of Westchester Co. The total population within this circle of 15 miles radius, by an approximate but careful estimate, we find to have been:

By the 1880 census	2,451,370
By the 1890 census	3,257,192
Increase (32¾ per cent.)	805,822

If we allow the census of 1890 to have been 100,000 in error in regard to the population of Manhattan Island (and it really seems to us if the evidence to that effect was very strong) the percentage of increase becomes 37 instead of 32¾, but in any case the increase is greater absolutely and about double as great per cent. as the increase of "Greater London" in the same time; while the total is, without allowance for any census errors, larger than the population of "Greater London" was 30 years ago (1861), when it was 3,222,720. Paris is now far behind New York, the population within the walls being only some 2,400,000. Within a radius of 15 miles a considerably larger population is included, which we have no means of estimating, but the city proper hardly extends out to the walls, and the population within a radius of 15 miles can hardly exceed 2,750,000. New York, therefore, has an excellent chance of becoming in fact, if not in name, the largest city in the world 30 or 40 years from now. It may or may not be that Chicago will in the meantime have outgrown it, but it has a good chance for doing so.

The Chicago "Tribune" has for some years past published a curious list of the total loss of life from other than natural causes in all parts of the world during each year, as reported in press dispatches. The total for 1891 footed up no less than 283,203, of which only 3,261 were chargeable to railways, 3,360 to ocean disasters, and 145 to lake and river disasters. The deaths by pestilence, chiefly in Arabia from cholera, and not including any from the grip, footed up 32,220. The loss of life in battle is given as 22,627, nearly half of it in Chile. The loss of life in this country from various kinds of disasters it gives as follows:

Drownings	2,421	Lightning	232
Cyclones and storms	133	Falling buildings	387
Fires	1,240	Railways	3,261
Explosions	771		
Mines	578	Total	9,023

Murders do not seem to be included. In addition to the above total of railway deaths, 2,707 are reported as seriously injured. These totals do not check very well with the official interstate returns, naturally enough, but for comparison with the "Tribune's" records of other casualties they are better than if strictly accurate. Of the railway casualties, 193 deaths and 441 injuries are reported as due to 24 principal accidents, 15 of which were collisions and 9 derailments. Of the 24 serious accidents, 8 happened in Ohio alone, and only 4 in the New England or Middle states.

The most wholesale casualties are reported from Asia, the largest single ones being 10,000 by floods in China, 7,650 by earthquake in Japan, 2,800 by floods in Spain, etc. The aggregate of Old World casualties is no less than 270,675, against only 5,762 in the New World. The aggregate for the entire world, as reported for some years past, have been:

1885	387,463	1889	107,013
1886	122,791	1890	114,543
1887	109,164	1891	283,203
1888	74,097		

These figures are to be taken with a great many grains of allowance for errors, and yet they have a certain interest as illustrating the frightful casualties to which mankind is exposed in the less enlightened countries.

THE CHICAGO WATER SUPPLY AND TYPHOID FEVER.

We have already published, in our issue of Feb. 27, 1892, an editorial under the above head, which used as a text the high death rate in Chicago from typhoid fever, which was over 16.64 per 10,000 inhabitants in 1891, and 7.19 per cent. of the total mortality. As we stated in that article, the cause was then, and is still, so far as it is possible to determine it, the pollution of the city's water supply by sewage. This sewage is discharged into the lake from a large district, stated on good authority to comprise a population of 200,000 people. In addition to this regular discharge of sewage the water supply is subject to further pollution at times, when the Chicago River and branches, all sluggish streams receiving much sewage, pour their accumulations of filth into the lake. This is liable to occur whenever the lake is low, whether the river be high or not. A strong westerly wind may at any time cause the Chicago River to flow into instead of out of the lake, and this result is especially likely to occur, and is especially objectionable, when a heavy rain or a freshet occurs at a time of low water in the lake, for then the river is flushed of foulness that may have been accumulating for months along its sluggish course. The report of the Illinois State Board of Health for the year 1885 states that for at least 40 days in the months of August, September and November, 1885, the sewage of at least 400,000 people was emptied into Lake Michigan, in addition to the regular discharge.

Since our first article, as above referred to, was written, the gravity of the situation at Chicago has been made more apparent by facts and figures mentioned further on. The high death-rate of 1891 and its almost certain connection with an impure water supply; the typhoid fever epidemic at Philadelphia in 1876, during the Centennial; the coming World's Columbian Exposition at Chicago in 1893, and the great importance of a pure water supply at that time; the recent epidemics of typhoid fever at Lawrence and Lowell, Mass., attributable to a sewage-polluted water supply, like the Philadelphia and Chicago epidemics; all these facts, together with the great general importance of the subject, led us, immediately after the Chicago epidemic came to our attention, to begin an investigation whose first results were published in an editorial in our issue of April 2, under the title, "Water Supplies and Typhoid Fever."

Most eminent authorities now agree that the principal vehicle for the spread of typhoid fever is the water supply of the community affected, especially when epidemics occur. In addition to the authorities and cases cited in our issue of April 2 we may mention here recent mild epidemics at Albany and Cohoes, N. Y., an account of which may be found in a paper by Prof. W. P. Mason, published in and reprinted from the "Journal of the Franklin Institute" for November, 1891, and entitled "Notes on Some Cases of Drinking Water and Disease."

At the beginning of these investigations we found that the situation at Chicago had been very carefully studied by Prof. W. T. Sedgwick and Mr. Allen Hazen, who first drew public attention, it appears, to the Chicago epidemic of 1891. The information collected by these gentlemen was of unique interest and completeness, and they have very kindly furnished us with an article embodying it, which, with two highly instructive diagrams and a statement of how they came to begin their investigations, will be found elsewhere in this issue.

The facts presented by Messrs. Sedgwick and Hazen seem to establish beyond all doubt (1) that typhoid fever at Chicago has reached truly alarming proportions; (2) that it has been increasing for several years, notably in the past two years, and that it is now much more prevalent there than in Philadelphia, New York, Boston, Baltimore, Cincinnati, London, or in seven German cities, named in the article, and including Berlin; (3) that typhoid fever at Chicago is due to the preventable contamination of the water supply of the city, and this last is in accordance with the view expressed in numerous official local reports, in a work entitled the "Sanitary History of Chicago," (a) and in the annual reports of the Illinois State Board of Health.

All the details of this proof are given by Messrs. Sedgwick and Hazen in their paper, and most of the proof is presented graphically by two diagrams, one showing for Chicago alone, and another for Chicago, Philadelphia, New York, Boston and London, the percentages of deaths from typhoid fever to deaths from all causes for each of the 22 years, 1870 to 1891, inclusive.

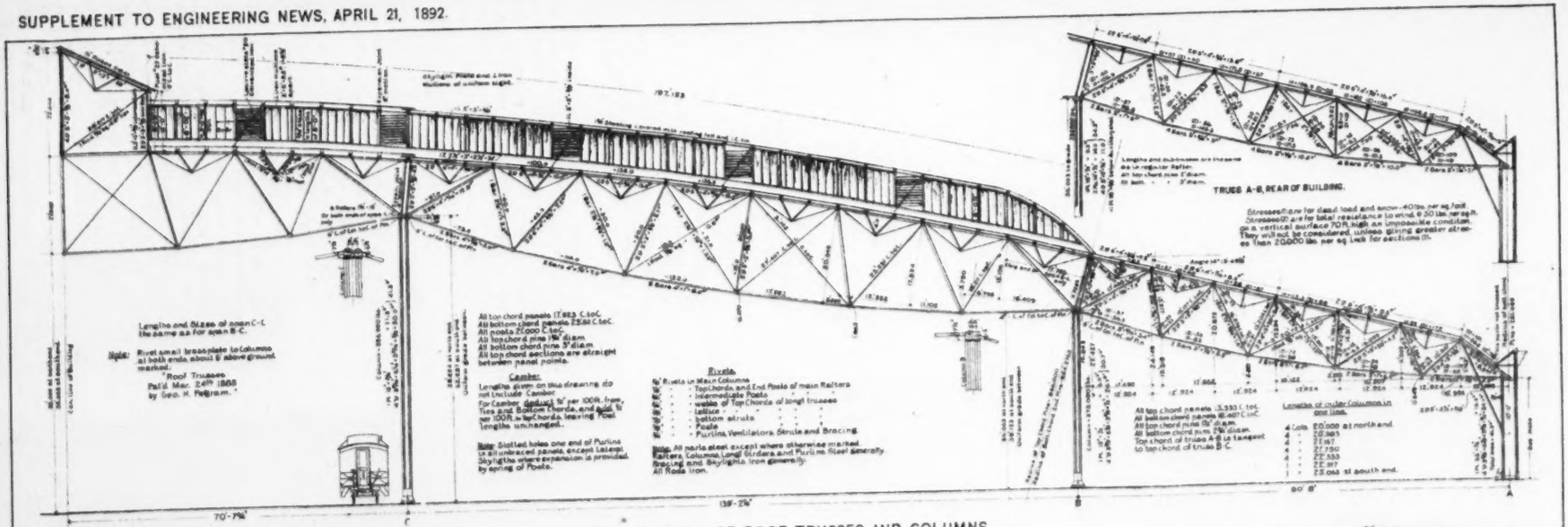
As the actual death-rates from typhoid fever in each city are given in separate tables in the article, and not in connection with each other, they have been brought together for convenience in the table below, and in connection with them we add the death-rate from all causes, as likely to be helpful in studying the situation.

Death-rates per 10,000 Inhabitants from All Causes and from Typhoid in Chicago, Philadelphia and New York, for the 22 Years 1870 to 1891, Inclusive.

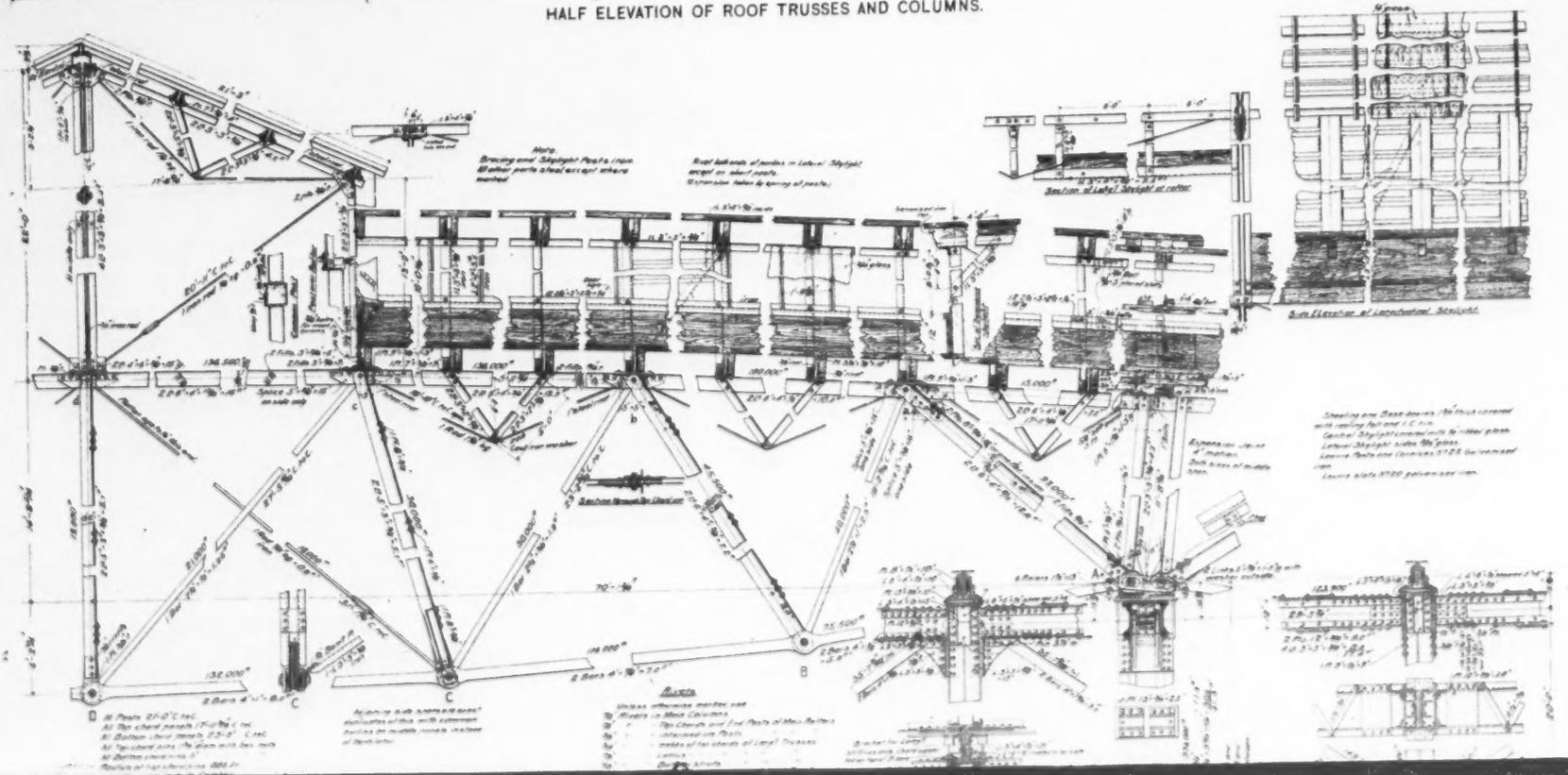
	Chicago.		Philadelphia.		New York.	
Year.	All causes.	Typhoid.	All causes.	Typhoid.	All causes.	Typhoid.
1870	246	9.00	227	6.06	288	4.47
1871	209	8.14	221	4 47	282	2.62
1872	277	14.26	262	5.09	337	3.98
1873	252	7.15	203	4.85	236	3.19
1874	205	5.34	197	5.95	279	2.96
1875	194	5.09	223	5 25	294	3.60
1876	204	4.00	217	9.22	274	3.02
1877	182	3.61	188	6.37	236	3.10
1878	165	3.24	179	4.61	237	2.81
1879	181	4.38	172	3.82	241	2.28
1880	208	3.40	209	5.88	294	3.06
1881	257	10.52	225	7.43	309	4.77
1882	236	8.24	226	7.33	295	4.02
1883	199	6.22	221	6.38	257	4.72
1884	198	5.62	215	7.13	257	3.49
1885	187	7.46	225	6.42	254	2.88
1886	195	6.86	206	6.36	258	2.99
1887	203	5.01	218	6.25	261	2.82
1888	190	4.52	200	7.72	261	3.37
1889	176	4.70	199	7.07	251	2.51
1890	182	3.40	207	6.36	246	2.16
1891	231	16.64	214	6.27	257	2.26
Ave'g's	208	6.90	212	6.20	270	3.19

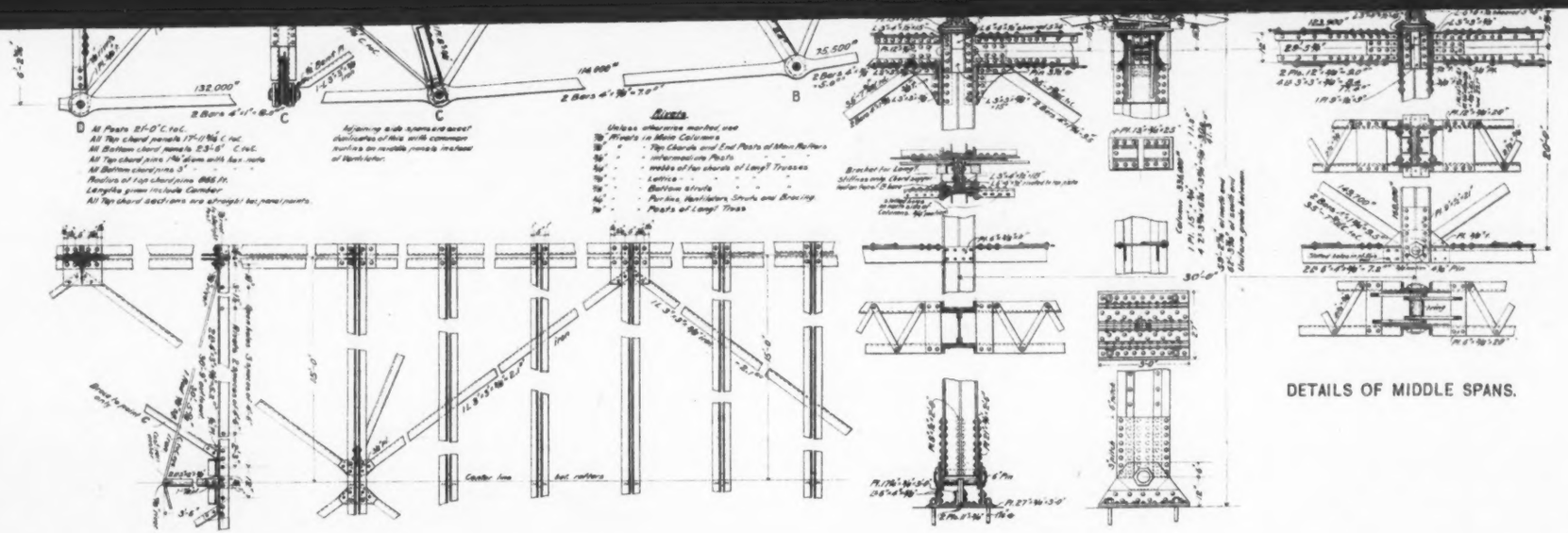
These figures show that from 1870 to 1873 (just before and after the great fire), as also in 1881 and 1882, and in 1885 and 1886, Chicago led Philadelphia

(a) "The Sanitary History of Chicago." Published by the Chicago Board of Health in 1871.

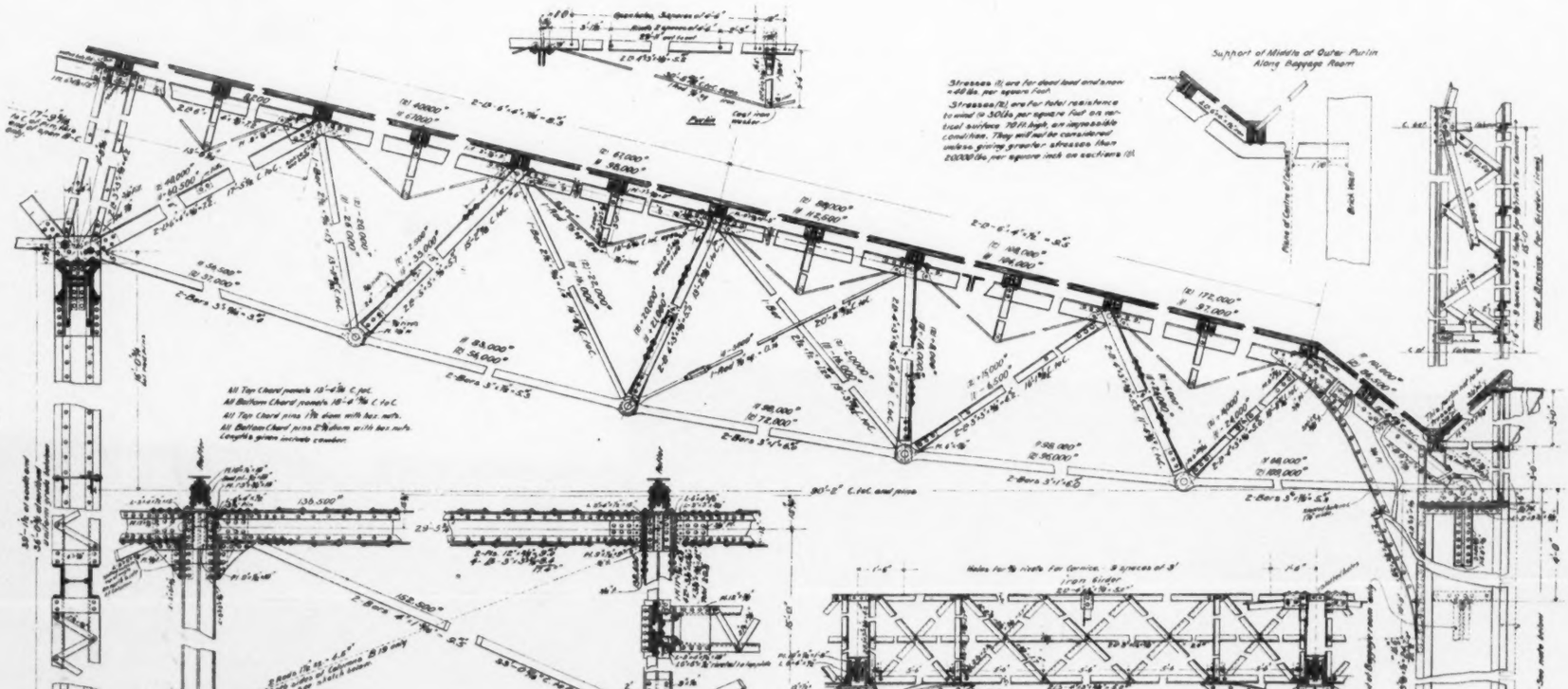


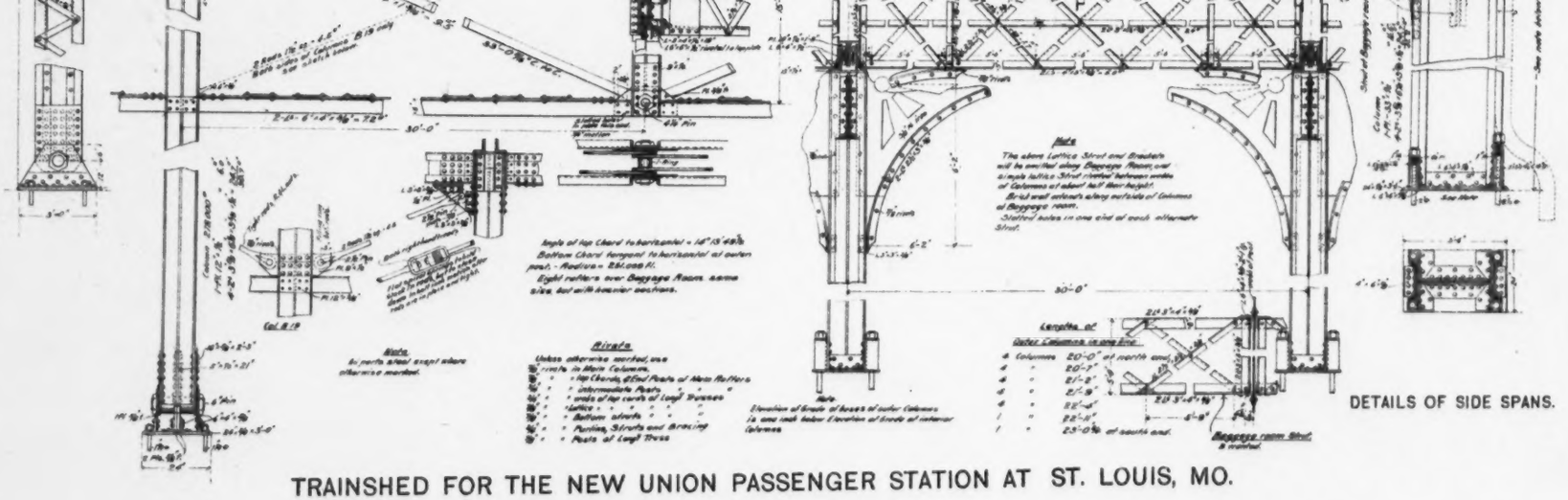
HALF ELEVATION OF ROOF TRUSSES AND COLUMNS.


Rivets
All Posts 27'-0" C. to C.
All Top chord panels 17'-8⅓" C. to C.
All Bottom chord panels 23'-0" C. to C.
All Top chord pins 1¾" diam. each end.
All Bottom chord pins 3" diam.
Section of top chord at Posts 666 in.
Section of Lattice 666 in.
Section of Bottom Chord 1000 in.
Section of Struts 1000 in.
Section of Rafter 1000 in.
Section of Purlin 1000 in.
Section of Ventilator 1000 in.
Section of Brace 1000 in.
Section of Strut 1000 in.
Section of Post 1000 in.
Section of Lattice 1000 in.
Section of Bottom Chord 1000 in.
Section of Top Chord



DETAILS OF MIDDLE SPANS.





DETAILS OF SIDE SPANS.

TRAINSHED FOR THE NEW UNION PASSENGER STATION AT ST. LOUIS, MO.

Geo. H. Pegram, Engineer.

CHAS. HART & SONS, LITH., 26 VESEY ST., N. Y.

in typhoid fever deaths, but that in the remaining 14 years of the 20 from 1870 to 1889, inclusive, Philadelphia had more deaths per 10,000 inhabitants than did Chicago; but for the whole period Chicago had a yearly typhoid death rate of 6.90 per 10,000 inhabitants against 6.20 in Philadelphia. For the 20 years 1870 to 1889, inclusive, the figures are 6.18 for Philadelphia and 5.88 for Chicago. In 1890 and 1891 Philadelphia went down and Chicago rose, so that adding the two years 1889 and 1891 to the previous 20 years Chicago leads in its average for the whole period. New York, in these 22 years, never had so high a mortality from typhoid fever as Chicago. Boston and London, it is evident from the diagram and from figures presented in the article, are far below Chicago, and on the whole it may be said that London, New York and Boston show a lessened death rate from typhoid fever as the years go on. There was a decided drop in Boston in 1878, when the new Sudbury River water supply was introduced, thus indicating practically how close is the connection between typhoid fever and the character of the water supply. In the last few years Boston has been taking great pains to exclude sewage from its water-supply, even going as far as to contribute toward the expense of works to purify the sewage of towns discharging into streams tributary to its supply. In 1890 and 1891 the percentage of typhoid fever mortality to the total death rate was lower than in any two previous years since 1870, the earliest date included in the article. In 1886, however, the above rate was 1.45 per cent., against 1.46 per cent. in 1891.

Philadelphia still drinks diluted sewage and veritably has its "ups and downs" of typhoid fever, as shown on the chart and in the tables. New York has never had a badly polluted water supply, comparatively speaking, since the introduction of Croton water. It shows a quite uniform rate with a marked tendency of late to decrease. At London a large percentage of the water supply is filtered and typhoid fever is comparatively rare.

When we come to Chicago we find a surprising record from 1852 to date, as shown in Table I. of the article. Chicago has had from the beginning a large amount of typhoid fever. This is all the more surprising when we consider that for many years Chicago has been congratulating herself upon the purity of her water supply. If properly protected she might still congratulate herself on this point. Messrs. Sedgwick and Hazen show conclusively by their figures and by their quotations that the people of Chicago have been warned of their danger from at least as early as 1858 down to date and they also show how conditions commonly held to be favorable to typhoid fever have in many cases been followed by it.

On the basis of its total death rate Chicago is a healthier city than either Philadelphia or New York, indeed much healthier than New York, as shown by the figures in the above table; Chicago having had for the last 22 years an average total death rate per 10,000 inhabitants of 208 against 212 for Philadelphia and 270 for New York. Therefore the excessive typhoid death rate in Chicago is all the more noticeable and the less excusable.

Leaving those interested in the details to follow out the reasoning of the article it remains to be said that the writers, although doubtless cognizant of it and in a measure indicating it by their quotations, have omitted one probable cause for a part of the increase in the typhoid death rate in 1890 and the great leap of 1891. It may briefly be stated, we believe, as follows:

In 1889, Hyde Park, Lake and Lake View were annexed to the city of Chicago. These sections had, and still have, water supplies independent of the main city, with intakes extending but a short distance from the shore. Lake View and Hyde Park discharge large volumes of sewage directly into the lake, contaminating, we believe, their own supply, rapidly multiplying their own typhoid death rate and helping to swell, since annexation, that of the city of Chicago. Of course it is evident that, unless these annexed sections have an enormous typhoid fever death rate, their annexation would not go far in accounting for the unusually large number of typhoid cases in 1890 and 1891. But it should be remembered that at Plymouth, Pa., 114 people out of a population of about 8,000 died from typhoid fever in six months, or at the rate of 285 per 10,000 per annum. Unfortunately, no statistics for the annexed districts, either before or since annexation, are at hand, or the facts of the case might readily be determined.

It is only just to say that Chicago now has an enormous area for which to provide public improvements, at least 180 square miles; that it is now engaged in numerous extensions and improvements of its water service, given in detail elsewhere in this issue; and that bids are now being asked by the Sanitary District of Chicago for one section of the long talked of Main Drainage Canal, involving the excavation of 11,500,000 cu. yds. of earth, and 5,000,000 cu. yds. of rock.

We are pleased to give the record, which will be found elsewhere in this issue, of the many improvements now under way to improve the quality of Chicago's water supply. All those measures which look to an extension of the water-works intakes to a greater distance from the shore, especially for the supply of the annexed district, can hardly fail to reduce the amount of typhoid fever. Yet the most important work, if the testimony of those who have given Chicago's sanitary condition the most study can be credited, is in the line of excluding sewage from the lake, and especially of improving the condition of the Chicago River.

We are glad to note that the Bridgeport Canal pumping station is being thoroughly overhauled and its capacity increased to a continuous pumpage of 60,000 cu. ft. per minute, as this seems to be one of the most important measures now under way.

The many improvements recorded elsewhere are all designed for completion before the opening of the World's Columbian Exposition in 1893, and are all calculated to allay the apprehensions which have been excited regarding the healthfulness of Chicago in 1893.

We cannot close this article without drawing particular attention to the great prevalence of typhoid fever in Philadelphia during the last 22 years, a rate nearly equaling the average of Chicago, and, as already noted, above Chicago for the 20 years, 1870 to 1889. The trouble is clearly with its water supply, but although Philadelphia has done a great deal of talking about improvement in the last few years, it has not as yet done much but talk. A filtering plant is proposed for part of the supply, and there has been an effort to take more water from the Schuylkill and less from the Delaware, but this is merely trifling with a serious evil demanding a radical remedy.

London, Boston and New York, whose water supply is known to be much better than that of Philadelphia or Chicago, have a much lower typhoid death rate than the last-named cities. The moral is obvious: Chicago and Philadelphia, and many other cities, should spare no effort to secure purer supplies, either by effective protection or purification of present sources or by providing new ones.

LETTERS TO THE EDITOR.

WIND STRAINS IN TRESTLES.

Sir: Permit me to direct attention to what I consider an inconsistency of no small importance in Mr. Lewis' specifications for railway bridges (Eng. News, April 2), which I think should not be passed unnoticed.

In designing trestle bents, Mr. Lewis specifies that the spread of base shall be determined by assuming a wind pressure of 300 lbs. per lineal foot on a train weighing 600 lbs. per lineal foot, this pressure to be considered as acting 9 ft. above the rail. Now, it is obvious that, inasmuch as the bearings of the wheel flanges on the rails are approximately 5 ft., c. to c., the train must weigh at least $\frac{300 \times 9}{2.5} = 1{,}080$ lbs. per lineal foot in order to successfully resist overturning from the stipulated wind forces, this weight being 80 per cent. in excess of that specified. This apparent inconsistency becomes all the more noteworthy in connection with the requirement that no tension shall be permitted in the windward trestle-leg.

In order to comply literally with the specifications in these particulars, the minimum allowable batter will be usually not less than 1 in 4, whereas 1 in 6 is the ordinary practice for single track trestles of moderate heights, which is found to yield in most cases perfectly safe results.

Assuming the viaduct to consist of 30-ft. deck girders, 3 ft. deep, supported on bents 30 ft. in height, then, according to Mr. Lewis' specifications, the overturning moment of the wind in reference to the base of the leeward leg will be:

$$(9{,}000 \times 45) + (4{,}500 \times 32) + (3{,}000 \times 15) = 576{,}000 \text{ ft.} = \text{lb}$$

Assuming 750 lbs. per lineal foot for weight of girders and track, and 250 lbs. per lineal foot vertically, for weight of bent and bracing, the dead load reaction for each column will be:

$$\tfrac{1}{2}(750 \times 30) + \tfrac{1}{2}(250 \times 30) = 15{,}000 \text{ lbs.}$$

The reaction from the specified live load for empty cars will be ½(600x30) equals 9,000 lbs., making a total reaction from dead and live load at each column base:

$$15{,}000 + 9{,}000 = 24{,}000 \text{ lbs.}$$

In order that there may be no tension in the windward leg, the spread of base must be at least:

$$576{,}000 \div 24{,}000 = 24 \text{ ft.}$$

With girders 9 ft., c. to c., as specified, this is equivalent to a batter of 1 in 4 for each leg.

On the other hand, if the weight of the empty train be taken at 1,080 lbs. per lin. ft., as would appear to be perfectly consistent, the reaction at the base of each leg would be increased ½(480 × 30) equals 7,200 lbs., and the resulting spread of base, to prevent uplift, without relying on anchorage, would be:

$$576{,}000 \div 31{,}200 = 18.5 \text{ ft.}$$

corresponding to a batter of only 1 in 6 1-3.

It can be readily shown that the ratio of the batters obtained from these data will not be materially altered for increased heights and spans, within moderate limits. Thus for a height of 50 ft., with 30 and 60-ft. spans alternately, the resulting batters will be approximately 1 in 4¼ and 1 in 6¼ respectively.

Excessive batters are objectionable for the reason that the weight of the transverse sway bracing is thereby rapidly increased. Again, it may happen that the spread of base is restricted by local conditions. The batter should in no case be greater than necessary to insure the stability of the structure, and with properly designed anchorage there is no good reason why a small negative reaction should not be permissible at the foot of the windward leg. Very respectfully,

Shreveport, La., April 6, 1892. Edgar Marburg.

A LEVEL TRUSS BRIDGE WITH INCLINED FLOOR.

Sir: In Engineering News of March 5 is illustrated a bridge built by the Missouri Valley Bridge Co., over the Kansas River at Fort Riley, Kan., in which the floor is inclined through a level truss. This arrangement of the floor is not novel. A bridge having the floor system arranged in this manner has carried the track of the Metropolitan Street Railway Co.'s Fifth St. cable line across the same river between Kansas City, Mo., and Kansas City, Kan., since 1887. This bridge consists of three through spans of the ordinary Pratt truss type, with a few short approach spans on the Missouri side.

The roadway is level on the approach spans and the adjacent through span, following the lower chord of the latter, but through the second and last main spans it is on a rising grade of about 8 per cent., writing from memory. The last and shortest of the three main spans is 115 ft. long, and is elevated above the position of the other spans in order to meet the requirements of headroom for the incline. If the writer remembers correctly, the general design for this bridge was made by Mr. J. A. L. Waddell, consulting bridge engineer of Kansas City, Mo. It was built at the Kansas City Bridge and Iron Co., (now of The Chicago Bridge and Iron Co.), and the constructive details were designed by the writer.

As the office and works of the Missouri Valley Bridge Co. are but a comparatively short distance from this bridge, appearances would seem to indicate that the design of the floor system of the Fort Riley bridge was copied from it. Benj. F. La Rue.

Jackson, Mich., April 12, 1892.

(The bridge was not represented to us by the builders as in any way novel. A photograph was sent to us, as many others are, that was all; and we of our own motion concluded to illustrate it as having sufficient novelty to be of interest, and probably useful as a hint.—Ed.)

THE YOUNG REVERSIBLE NUT LOCK.

Sir: In your notice last week of the Young reversible nut lock I observe two typographical errors which I would be pleased to correct. The thickness of the lock nut is either 3 or 4 times the pitch of the thread instead of "3½ or 4½ times" as you are made to say, because in reversing the lock we must not only place the opposite face of the lock against the nut but must also gain one-half of a complete revolution at the same time, and this can only be done when the thread in the lock begins and ends in the same perpendicular line as regards the face of the lock. I may note also that my address is 150 Broadway instead of 150 Liberty St. Thanking you for the courtesy of this correction, I am,

Yours truly,

New York, April 18, 1892. Ira Abbott, C. E.

(The error in regard to number of turns was our own and not the types. It appeared to us at first sight that in order to effect by reversion the desired change in position when screwed up (180°) it was

necessary to have the thickness of the nut a half over an even number of turns, but we perceive that we were incorrect.—Ed.)

THE RENO TUNNEL SYSTEM.

By J. W. Reno, E. M.

(Continued from page 321.)

Broadway, New York, from Union Square to the Battery, is underlaid by a perfect network of pipes, electric subways and cable road structures. The sub-surface material, as shown by the borings made by direction of the Rapid Transit Commission, consists of a gritty sand extending down to the bed-rock, and in several places is 150 ft. deep. In the two miles between 10th and Morris Sts., the rock nowhere approaches nearer to the street surface than 35 ft., and for three-fourths of this distance the water line is not less than 30 ft. below the surface. The street is at some points only 34 ft. between curbs, has a vault area under the sidewalks owned by the property holders, and is lined on either side by blocks of costly buildings. Taking all these conditions into consideration, the writer believes that the system of tunneling and form of tunnel here described is particularly applicable to the case.

The engraving (a reproduction from a model) shows in perspective the double-decked tunnel in which the sides, floor and roof are composed of cast iron girder panels provided with strengthening webs and flanges. These panels are braced internally by the system of columns and girders shown, which divide the space into four compartments or trainways. The method of driving the tunnel will be by means of an inclosed hydraulic shield which, instead of having the usual circular form, will be given the outline indicated in the engraving. The square shield thus designed can be braced vertically, horizontally and diagonally, and in other respects will be similar to the well-known circular form. The procedure in driving the tunnel is also quite similar and will consist in forcing the shield forward by its hydraulic jacks, a distance of two feet, after which operation there are placed in position the eight cast iron girder panels which make up the periphery or lining of the tunnel. When these panels have been inserted and bolted through their flanges to the adjacent ones the I-beam columns and girders will be erected at their four points of intersection. In the rim or back of each panel holes are provided through which will be forced a grouting of hydraulic cement for the two-fold purpose of filling the void left by the advancing shield and also to protect the iron from corrosion. This latter, however, will be more thoroughly secured by previously coating the exposed surface of the panels with asphalt.

The girder panels for the sides, floor and roof are of similar design, the rim or back of each having an elliptical curve, in order to obtain maximum strength with least weight. The purpose of the mitered or 45-degree flange at one end of the panel is indicated in the engraving, and in order to give additional rigidity to the tunnel structure this mitered flange has cast in it a keyway for a short dowel pin which will relieve the bolts, clamping the flanges of the panels from any possible shearing strain, and also counteract the tendency for one flange to slip upon the other at this point. The dimensions of the girder panels given in Fig. 2 are calculated for a load of 2,000 lbs. per sq. ft. The inside dimensions of the tunnel are only 22½x22½ ft. for the design of car body, 9 ft. wide by 8½ ft. high, illustrated in Engineering News of April 2.

The rails of the express tracks will be carried upon hard wood ties, imbedded in cement between the flanges of the floor panels, so that no space need be lost here, and also by this arrangement an admirable roadbed for high speeds will be obtained. To further economize space the local tracks will be carried just clear of the transverse I-beams by an application of one of the shallow bridge floor systems, and as the I-beams are but 2 ft. between centers, a 9-in. beam will give ample strength for the supporting girders. A board walk for employees is provided at each side of the center columns, so that it will only be necessary for the workmen to stand between them in order to avoid passing trains. The open spaces between the columns and girders permit a free circulation of air throughout the four tracks, so that only a single system of ventilation will be required. This open and internal structure is also important because of the opportunity given for the air to part in front of the rapidly moving trains instead of its being pushed ahead of them.

It may be contended that the double-decked tunnel will produce more noise than would the four-track level one, because of the fact that the upper tracks are carried upon an iron structure. The tendency to vibration and noise, however, can be effectively guarded against by the use of a heavy rail section set upon some cushioning form of tie plate, and as in the tunnel it will be subject to very slight expansion and contraction, a practically continuous rail joint will be possible, and thus a smooth track assured.

In his published report to the Rapid Transit Commission, Mr. Octave Chanute, at the same time that he compliments this tunnel system upon its good features, implies a doubt as to its practicability because of the depth of the floor of the tunnel below the surface, which he gives as 38 ft. As a matter of fact, there is a large error in this statement, for by taking the depth of the tunnel roof as 7 ft. 9 ins., which was his basis of comparison with the wide tunnel, the floor of the Reno tunnel will be 31 ft. 6 ins. instead of 38 ft. deep, as given by Mr. Chanute. As the method proposed for driving this tunnel by the inclosed hydraulic shield (also advised by both Messrs. Chanute and Cooper) has been successful on very much more difficult ground than is shown in this case and at depths several times greater, it is considered that the above objection has little weight. In a narrow street like Broadway, a comparison of widths of tunnels is really of greater importance than that of depth, when considered with due regard to the difficulties of construction and the great value of the subsurface area required.

Theoretically, the point may be raised that the rectangular section given to the double-decked tunnel is not so well adapted to resist external pressure as the circular section. The plan to put the four tracks double-decked in a single circular tunnel is hardly worthy of consideration as the attempt to brace this form at once destroys its efficiency in resisting pressure. The objection to the plan of placing the tracks in four separate tunnels arises principally from the cost of construction and the difficulty in constructing the tunnels to allow of cross overs between them. In addition to this the problem of ventilation in the plan of four separate tunnels is very complicated. The availability of the writer's tunnel system, therefore, depends mainly upon the question whether it is possible, within reasonable limits of cost, to make the iron girder panels which compose the sides, floor and roof, of sufficient strength to resist the external pressures.

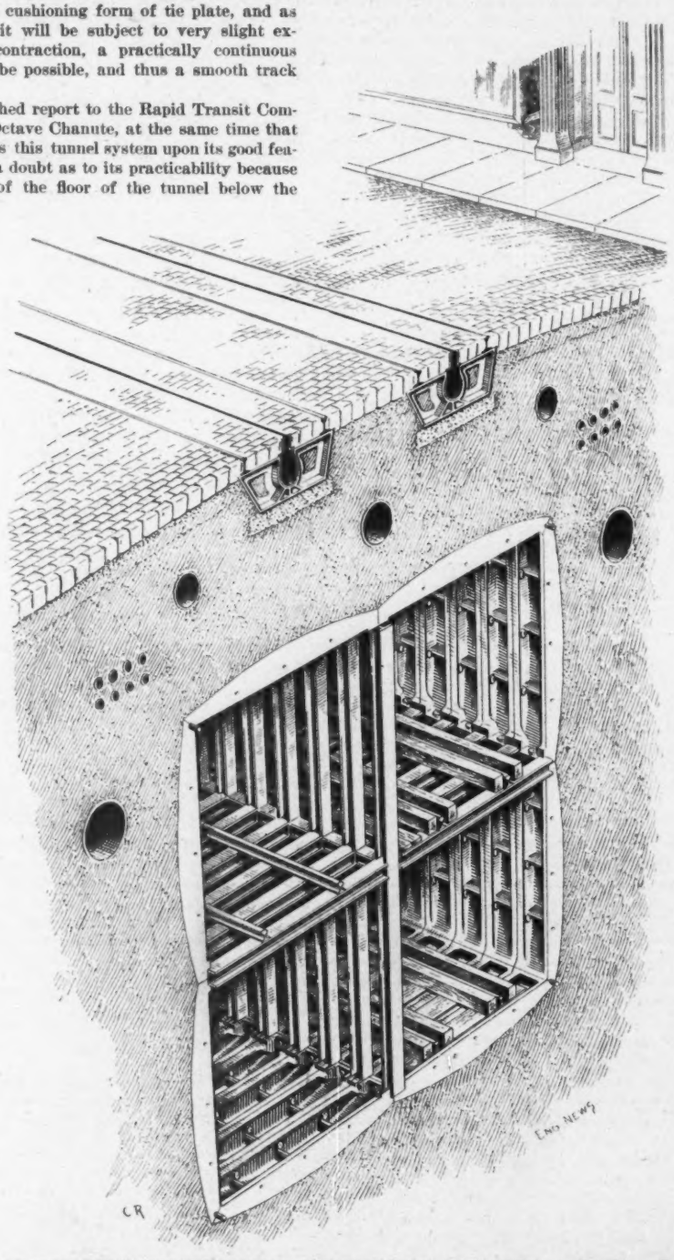


FIG 1. PROPOSED RAPID TRANSIT TUNNEL FOR BROADWAY, NEW YORK; J. W. Reno, Engineer.

In considering this point, however, it must be remembered that the gritty sands through which the tunnel is to pass do not transmit vertical pressures for any considerable distance horizontally, because the friction between the particles of sand absorbs the force. Therefore, as the foundations of the heaviest buildings extend almost as deep as the floor of the tunnel, while those of the smaller buildings will be more than 30 ft. distant, no great pressures can possibly reach the girder panels from this source. The vertical pressure on side panels due to weight of the roof, will also tend to counteract the external thrust upon them. In the case of the floor panels they will be seen to have, through the grouting, a firm bearing upon the ground from one end to the other, and thus serve to distribute the pressures equally over its surface. Consequently it is considered that the design of panel calculated for the assumed load of 2,000 lbs. per sq. ft. at the roof of the tunnel will have ample strength for either the sides or floor. In this calculation the cast iron girder panels have been taken as having a span of 11 ft. 3 ins. (for other dimensions see Fig. 2), and are

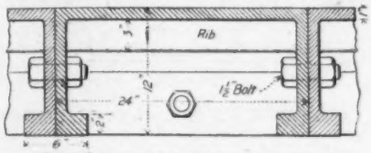


Fig. 2. Section Through Girder Panels.

consequently each able to support a distributed load of 120 tons before breaking. As they are 2 ft. wide the assumed load amounts to about 24 tons, so that we have here a factor of safety of five.

The internal or bracing structure of the tunnel is composed of heavy 9-in. I-beams weighing 115½ lbs. to the yard. In the case of the columns, these are each capable of supporting a bending load of 115 tons, which, including the train loads, will give a factor of safety of four. The horizontal I-beams, 2 ft. apart, each capable of carrying a safe load of 12 tons, of ample strength for the local train traffic. The short I-beams, shown at the axis of the tunnel, connecting and bracing the vertical columns, add greatly to the rigidity of the structure, so that in the calculations for strength the columns can be regarded as having but half their total length from the roof to the floor of the tunnel.

Reno Tunnel System. Approximate Cost per Mile.

21,120 cast iron girder panels, weighing 1,900 lbs. each; total 20,064 tons @ $35	$702,240
1,902 tons 9-in. I-beams (115 lbs. per yd) @ $60 per ton	114,120
Excavation of ground and disposal of material, 112,640 cu. yds. @ $1.50	168,960
Fittings internal structure, bolts, etc.	50,000
Cement grouting and asphalting panels	40,000
Contingencies and engineering	100,000
Total	$1,175,220

IMPROVEMENTS TO THE CHICAGO WATER SUPPLY.

In view of the articles appearing elsewhere in this issue, showing the need of improvements to the quality of water furnished the city of Chicago, we wrote to Mr. Bernhard Feind, First Assistant City Engineer, asking him to state briefly just what is now being done in the way of water supply improvements. Mr. Feind has very kindly sent us the information given below, which shows that Chicago is awake to the necessity of providing an ample water supply before the opening of the World's Columbian Exposition and is taking some much needed steps to improve the quality of the water. Mr. Feind gives the following account of the improvements now underway, or soon to be started, the statements, Mr. Feind informs us, being subscribed to by City Engineer L. H. Clarke:

1. A new 12,000,000-gallon pumping engine at the Lake View Works, a Gaskill. The Holly Manufacturing Co. were the lowest bidders. Term of completion 60 days, including 30 days for foundations to be put in by the city. The station buildings will be entirely reconstructed, the new floor to be 6 ft. lower than the old floor; will be ready for work early in July.

2. A temporary intake for the Lake View Works over the end of the new 6-ft. tunnel, finished so far about 6,000 feet from shore. Timber and stone hexagonal crib with open inner well on a 6-ft. cast iron shaft in the latter. Will also be ready early in July.

3. An improved shore intake, 4,500 ft. from shore, off North Side Works, is now ready to be used; has not been used at all yet; 7 ft. tunnel. Intake is in 7 ft. of water at the northwest end of exterior Government breakwater. This will furnish good water with easterly winds; doubtful and exposed to taint of Chicago River with westerly winds and low lake levels, and in times of large precipitation in Chicago River and Desplaines River valleys.

4. The well-known four mile tunnel has only a little more than 1,500 feet to be done; expect to make headings meet in the middle of June, but several months will be required for cleaning and repairs. This tunnel will be opened in the fall. There are two 6-ft. tunnels for the first 2½ miles, and one 8-ft tunnel for the last 1½ miles. There will be 40 ft. of water at the intake. Average progress has been 100 ft. per heading per week, for a long time. Compressed air is used with an average pressure of 15 lbs.

Gates and by-pass tunnels, in connection with the above, have been finished which will allow of:

5. Temporary use of new land tunnel system (properly dependent on four mile tunnel), by water taken from old intake two miles out. This too, without disturbing use of shore shaft of the four mile tunnel, located on the line of the new land tunnel. The new 14th St. pumping station with three triple expansion "Reynolds" engines, each of 18,000,000 gallons capacity will be made ready for operation by means of this water from the old intake, drawn through the new land tunnels. The new 14th St. station will be run soon to enable the shutting down of a large portion of the old pumping works on the West Side for repairs. One or two of these new engines can be used in addition to all of the old ones, if flow is increased by opening wholly or partly the shore gate of the improved shore intake described under paragraph 3. In such case the second one of the two triple expansion "Reynolds" engines at the central or 14th St. pumping station, which has never been used for lack of water, can also be operated.

6. Extension of the 68th St. tunnel, which is 6 ft. in diameter and 5,000 ft. long, by a 7-ft. tunnel to a point two miles out. A permanent crib, hexagonal, of timber and stone with a cast iron intake shaft 10 ft. in diameter will be built 10,000 feet or so out. A similar but temporary crib, for purposes of expediting work, will be built about 6,500 ft. out. Bids for this tunnel and extension and the cribs were opened April 15. Lydon & Drew were the lowest bidders. Time of completion, nine months from date of contract. This would bring opening into February, 1893.

7. Two new 12,000,000-gallon pumping engines at the 68th St. station, to be used exclusively for World's Columbian Exposition purposes during the six months while it is open, but otherwise part of the city water supply system. These engines are up, the boilers are being set, piping (a good many complicated special castings) will begin to be laid in June. Expect to have engines ready for work in July.

8. Doubling of capacity of small "Washington Heights" pumping station, which supplies a separate district from an artesian well. Bids will be called for. Will be done by end of June.

9. Essential improvements in machinery and channels (inflow and outflow) at the Bridgeport canal pumping station are being made now. The intention is to increase the speed from 75 to 100 revs. per min. Expectation is to realize a full discharge of 60,000 cu. ft. per minute, permanently. All the boilers are now new and there are more of them than before. Solid through-shafts with two end-bearings for wheels of pumps will be used.

The aggregate daily capacity of the several pumping engines to be added to the various plants during 1892 and now either finished or in course of erection is 100,000,000 gallons. This aggregate is made up as follows: Four 18,000,000, three 12,000,000 and one 1,000,000-gallon pumps.

LONDON'S NEW METROPOLITAN GOVERNMENT.

Few of our readers probably realize that only four years ago London, the world's metropolis, had literally no municipal government, and that now the Lord Mayor of London rules only over inner London, "the city," with a resident population of less than 30,000 at the present time. The five or six millions of people living in the extensive area which constitutes the real metropolitan London have been, until very recently, ruled only by parish vestries and district boards, in many small, irregular divisions. All this and more, too, is told in an able and most interesting paper published by Mr. Albert Shaw in the April issue of "The Review of Reviews," and from this journal we make the following abstract:

The "City of London" occupies a territory of about one square mile only, with the resident population given above, and has for centuries been governed by incoporate gilds with immense accumulations of wealth. These gilds collectively constitute a city corporation, elect a board of aldermen and annually make one of these aldermen the Lord Mayor. As Mr. Shaw says, the original London remains "a case of arrested development, with a fossilized mediæval frame work of government."

Fifty years ago London was without underground sewers, street lighting worthy of the name, street railways or systems of transit other than a few omnibuses and cabs, or well paved streets. The disposal of house and street refuse, paid fire department, building regulations, public education, public parks, playgrounds, libraries, and in fact practically all the elements that are now deemed essential for the proper government of cities were lacking at that date. The municipal reform act of 1835, which made a beginning possible in the good work since accomplished in many other English cities, was not applicable to London at all. The metropolis was regarded as exceptional and reserved for separate treatment, which was delayed for nearly 60 years.

All that there is in London of main drainage, some important street improvements and a few other matters of general concern, have been in charge of a so-called "Metropolitan Board of Works," constituted some 30 years ago, and made up of delegates sent by the local district boards and parish vestries, neither efficient nor well constituted. Four years ago not one Londoner in thousands could have explained how and by whom his city was really governed, and the result was apathy in regard to city affairs and the absence of all municipal spirit or interest.

There had long been a clamor for reform in the government of the counties of England, and in 1888 the Government brought in a bill, which finally became a law, which created for each county an elective central council. Incidentally, as a part of this local government bill, "The Metropolis" of London was created into a separate county, and provision was made for a county council and central authority for the long-deferred municipal government. The first council was elected for a three-year term in 1889, and the second was elected in March of this year. Under this council the minor affairs still continue generally under the control of the local boards and parishes, except that various functions have been taken from them and bestowed by law upon the central council. This council adds to its number by electing 19 citizens of London to sit and act with it as aldermen. The presiding officer is a chairman elected by the council. The "City" is allowed a representation in the county council as one of the districts constituting the larger metropolis, but still retains its Lord Mayor and aldermen.

While yet far from being perfect, London has at length the framework of a great municipal government, established upon sound and workable lines, though as yet the powers of the council are comparatively limited. It has all the powers of the old Metropolitan Board of Works, with other powers conferred by the statute creating it, and in due time it will absorb within itself all the powers wielded by the local boards and, doubtless, those of the inner London.

The area of the present County of London is about 120 square miles, and the population of this area is about 4,500,000. But before long it will absorb all within the metropolitan police district, which extends in a radius of 15 miles from Charing Cross and includes a population of between five and six millions. But with this greater area the system of representation will remain the same, with the whole authority vested in one central body. The policy of the present council points toward the appointment of single expert chiefs, holding office permanently by merit, at the head of each of the working departments of the city, with each department supervised by a standing committee of the council. The subordinate offices will be upon a purely civil service basis, with a minimum of patronage; the chairman of the council will have no veto power and no appointing power. But there will be a general "steering committee," made up of the chairman of the County Council, chairman of the General Purpose Committee, and the chairman of the Finance Committee, acting something like a parliamentary cabinet.

The recent vigorous political campaign, which resulted in the triumph of the progressive party in London and the electing of a still more influential County Council, indicates the work that is to be performed by this new municipal body. The opposition represented the Tory element in London, the Conservatives, who see danger to vested interests and long-established usage in London affairs. The battle was fought under the name of the "Progressives" and the "Moderates." The first defended the general policy of the London Council; they stood for taxation reform, which would make the great landlords and holders of ground rents pay their share of municipal revenue; for the extinction of the eight great water companies, and a directly owned and managed public supply; for the reform of the housing conditions of the poor, and generally for the enlargement of the powers of the County Council by further acts of Parliament. The Moderates simply opposed "the extravagant and utopian" projects of the first council and their campaign was directed by the great land owners, the water companies and other monopolies, and all who felt an interest in preserving the old conditions. The victory of the Progressives was a brilliant one.

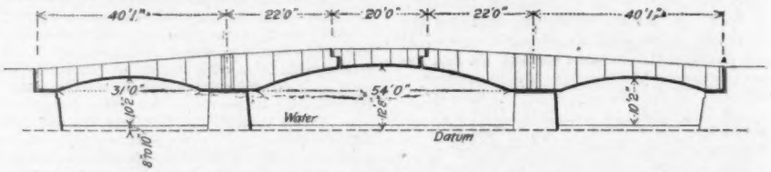
Mr. W. T. Stead, in an "Elector's Guide," points out who the men are who control this County Council. The 137 members elected in March are headed by Lord Roseberry, who was chairman for the first term, and Lords Hobhouse, Compton and Lingen, and in this whole membership there are none but citizens of the very best repute. The members serve without any compensation whatever, and are generally men who have dedicated themselves to the service of London, and in some cases have sacrificed their business and injured their health in this service. Mr. Stead says that while some devote all their time to the work of the council, each councillor gives on an average two days out of each week to the service of the town of London. Lord Roseberry, with the other Lords mentioned, is a Liberal, and has shown a broad and zealous interest in the progress of London, and says that one of his objects is to remove from London its reproach of being "a quarter of the very rich surrounded by a vast nation of the very poor." Lord Roseberry is succeeded as chairman by Sir John Lubbock, a distinguished scientist, banker and statesman. John Burns, "socialist," "demagogue," and "agitator," has been one of the ablest and most influential members of the council, and is still there and a favorite with the other members for his honest, fearless advocacy of the rights of the class he represents. He has done more, says Mr. Stead, to advance the cause of labor than any single workingman has done in any three years of the history of the nation, and has made substantial gain for his people—the poor and the workingman. Among the other members are Sidney Webb, a political economist of the advanced socialistic class; and Charles Harrison and Sir Thomas Farrar, eminent financiers. Mr. Stead concludes his remarks on the County Council by saying that "During the three years a considerable share of as fine ability as the English-speaking world could produce and of as high zeal and civic patriotism as can be found anywhere have been brought to the service of the new London municipality."

WORLD'S COLUMBIAN EXPOSITION.

Steel Bridges Over the Canal.

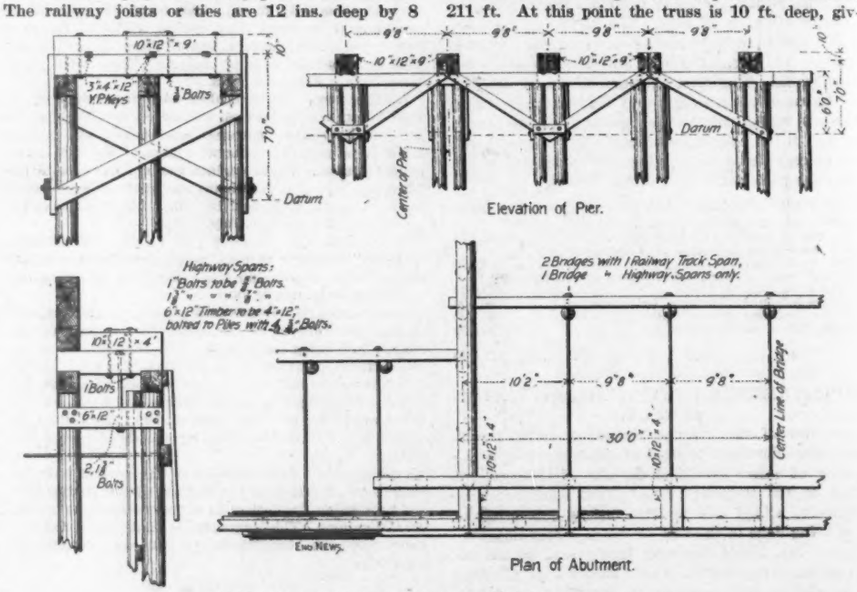
A contract for the construction of three steel bridges across the canal which connects the lagoon with the grand basin, as shown on the map in our issue of Jan. 16, has been awarded by the Bureau of Construction, by whom the bridges were designed, to the Massillon Bridge Co., of Massillon, O., at $15,900. The work is to be completed by June. One of these bridges will be for a roadway only, and will be situated between the Electricity Building and the main entrance of the Manufactures Building. The two others will be roadway bridges with a railway track at one side; one of them will be situated between the Machinery and Agricultural buildings, and the other between the Electricity and Manufactures buildings. They are built entirely of steel, and the construction will be done under the specifications prepared by the Bureau of Construction, which were given in full in our issue of March 26.

They are plate girder deck cantilever bridges of graceful appearance, divided into three spans with arched bottom chords, as shown in the outline elevation. They are 144 ft. 2 ins. long over all, with a rise of 4 ft. from the ends to the middle. The width is 58 ft., with seven rows of longitudinal girders, the outer pairs of which are connected by a wind bracing of ¾-in. rods as shown on the plan. The middle span is 54 ft. in the clear, with the lower chord having a radius of 69 ft. 1 in. and a rise of 5 ft. 6 ins. The two side spans are 31 ft. in the clear, with the lower chord having a radius of 41 ft. 7 ins. and a rise of 3 ft. The clear headway above average water level will be 12 ft. 8 ins. at the middle of the center span and 10 ft. 2 ins. at the middle of the two side spans. The middle span is made up of two cantilever arms 22 ft. long from center of pier, carrying a link or suspended span of 10 ft. The depth of the arms is 7 ft. 7 ins. over the piers, and



OUTLINE ELEVATION OF STEEL BRIDGES OVER THE CANAL; WORLD'S COLUMBIAN EXPOSITION.

the suspended span is 3 ft. deep at the middle. The girders of the side spans are 3 ft. deep at the middle and 4 ft. 6 ins. at the abutment ends. The lower half of the free end of each cantilever arm is extended to form a seat for the projecting upper half of the girders of the suspended span. The timber floor beams or joists are carried by shelf angles underneath, and parallel with, the top chord, and riveted to the web plates. The roadway joists are 12 ins. deep by 2 ins. wide, spaced 14 ins. c. to c. The railway joists or ties are 12 ins. deep by 8



PIERS AND ABUTMENTS OF BRIDGES OVER THE CANAL.

ins. wide, spaced 18 ins. apart c. to c., and are secured by ¾-in. drift bolts driven through the inner flange of the top chord of the girder. The floor is of 2-in. planking, laid diagonally. The material for the girders is as follows:

	Railway. Ins.	Highway. Ins.
Cantilever girder.		
Top and bottom flanges; 2 angles	6 × 4 × ⅜	4 × 3 × ⅜
Top and bottom flanges, 1 plate	12½ × ⅞	.....
Stiffeners	3½ × 3½ × ⅜	3¼ × 2½ × 5/16
Splice plates	6 × ⅜	6 × ⅜
Link girder.		
Top and bottom flanges, 2 angles	3 × 2½ × ¼	2½ × 2½ × ¼
Stiffeners	3 × 2½ × 5/16	2½ × 2½ × 5/16
Splice plates	6 × ¼	6 × ¼
Shelf angles	3 × 3 × ⅜	3 × 3 × ⅜
Web plates, over piers	½	¼
" " all others	¼	¼

The piers and abutments will be of pile and timber construction as shown on the drawings, which represent the arrangement for the railway spans. The piers for the highway spans will be similar, with the exception of the oak keys. The abutments for the highway spans will be the same, with the following exceptions: ⅝-in. and ⅞-in. bolts will be used instead of 1 in. and 1⅛-in. bolts respectively; the cross timbers will be 4x12 ins. instead of 6x12 ins. and will be bolted to the piles by four ¾-in. bolts. All bolts are to have standard ogee cast iron washers, except at the bed plates. The height of bridge seats on piers and abutments will be 7 ft. 10 ins. above datum, or about 7 ft. above the average water level in the canal, which will be 8 to 10 ins. above datum. The elevation of upper and lower terraces along the canal will be 11 ft. 6 ins. and 6 ft. respectively above datum. The exterior of girders and piers will be covered with staff, and handrailings of ornamental design will be provided across the bridge.

Trusses for the Manufactures Building.

The first two roof trusses of the central hall of the Manufactures building at the World's Columbian Exposition were completed April 13. It required nine days to erect the trusses. The succeeding pair of trusses will probably be placed in position in six or seven days. The trusses have a span of 380 ft. outside measurement. They are 14 ft. wide at the base, which gives a clear span of 352 ft. The extreme height at the apex of the arch is 211 ft. At this point the truss is 10 ft. deep, giving a clear height from the floor of 201 ft. They weigh 300,000 lbs. each, without the purlins or connecting structure. With the weight of the purlins added, the 27 main trusses average 400,000 lbs. each. Before the erection of these trusses, the largest roof trusses in existence are said to have been those in the Jersey City terminus of the Pennsylvania R. R. (Eng. News, Sept. 26, 1891), which are 252 ft. 8 ins. span c. to c. of piers, and 89 ft. 9¾ ins. high. To erect the great trusses of the Manufactures Building a traveler was constructed on the floor of the building, 50 ft. deep by 260 ft. wide and 120 ft. high. On top of this traveler was raised a central tower 135 ft. high, so that the total height was 250 ft. It weighs 720,000 lbs., and over 500,000 ft. of lumber were used in its construction. The traveler runs on a track specially prepared for it. A part of the floor was torn up

and three rows of piles driven to support the traveler. When the work of raising the trusses is finished, this piling will be sawed off and the floor relaid. The big Rookery Building, Chicago, which is about 14 stories high, could be placed under this roof. The contract for the trusses was let to the Edge Moor Bridge Works, Edge Moor, Del.

THE STATE RAILROAD COMMISSIONERS' CONVENTION.

The fourth annual convention of the state and interstate railway commissions was held at Washington, April 13 and 14, at the rooms of the Interstate Commerce Commission. Reports of committees were presented on the following subjects: "Safety Appliances," "Uniformity in Railway Accounting," "Territorial Assignment of Statistics of Operation," "Railway Legislation," "Reasonable Rates," and "Discriminations Arising from the Use of Private Cars of Shippers." The report on safety appliances merely gave the statistics collected and the bills presented by the committee, (See Eng. News, April 2, page 328, and Nov. 14, 1891, page 469). The convention authorized the filling of the vacancies on this committee, and directed the committee to "urge upon Congress the immediate passage of such bills as may most effectively insure the equipment of freight cars throughout the country with uniform automatic couplers, and with train brakes, and the equipment of locomotives with driving wheel brakes."

The Committee on "Uniformity in Railway Accounting" presented a report in favor of including taxes under the head of operating expenses, chiefly on the ground that to state the operating expenses and earnings without including taxes, gives an exaggerated idea of the profits of the railway from its operations. There was a long discussion on this recommendation, and it was finally decided by a vote of 22 to 17 that taxes should not be included under operating expenses. The committee also recommended that the arbitrary assignment of expenses to freight and to passenger service which has been adopted by the Interstate Commerce Commission should be abolished. The great variation in the character of traffic and in the relative proportion of passenger and freight traffic on different roads makes the application of an arbitrary apportionment incorrect and misleading, especially to legislators who attempt to proportion rates to cost of service. The subject was referred to a committee, to report at the next annual convention.

The most interesting report presented was that on the evils arising from the use of private cars by shippers, prepared by Mr. John R. Wheeler, of the Illinois Commission. The report reviewed the old "commission lines," the fast freight lines and car trusts, explaining how each of these devices operated to rob the railway for the benefit of private parties. As an example of the profits to be made from the successful working of a car trust, 2,000 cars costing $900,000, or $450 apiece, were rented to a railway company at $81 per year, the railway keeping the cars in repair. At the end of three years the cars were sold to the railway company for their original cost, less 6 per cent. for two years, amounting to $792,000, notwithstanding the fact that the railway company had already paid to the trust in the way of rentals more than half the cost of the cars when new. The amount received by the trust for rental during the three years was $486,000. Add to that sum the amount received from the sale of the cars, and we have $1,278,000, from which deduct the original cost of the cars ($900,000) and there was a net profit of $378,000 to the trust. This profit, moreover, was made with practically no investment of capital, the rentals paid by the railway company being sufficient to meet the payments for the cars as they became due.

The report then related how the use of private cars was forced upon the railways by such powerful corporations as the Standard Oil Co., and also by men who were directors of railway companies, and at the same time interested in live stock or refrigerator car lines.

The discriminations resulting from the use of private cars are: (1) The mileage is excessive, enabling the recipient to use a portion of his receipts in this way as a rebate to secure shipments. (2) The special facilities afforded by private cars enable those using them to monopolize the market to the exclusion of small shippers. (3) The owners of such cars obtain annual passes for their officers. As an extreme example, a wholesale firm, owning a single car, appointed one of their number president, a second, vice-president, and a third, general manager of their one car and obtained annual passes for the three.

More than 70,000 private cars are in use in the United States. The average car movement of the entire United States is estimated at 24 miles per day. If these private cars made only the same average mileage as other cars and were paid for at the regular rate of ¾ ct. per mile, they would yield $4,600,000 in the course of a year. The movement of these cars, however, averages at least double that of ordinary cars, and on a considerable number a higher mileage rate than the standard is paid.

From four of the larger systems of railways in the United States the following official statement has been obtained of the average daily movement (Sundays included) of freight cars of various classes:

	Railway.				
Average daily mileage of:	A.	B.	C.	D.	Av.*
Company's cars on Co's lines....	31	34	32	...	32.3
Company's cars on foreign lines..	22	27	26	...	25.
Foreign cars of all classes on Company's lines.....	44	63	38	...	48.3
Private refrigerator cars on Company's lines.....	82	75	84	84.5	81.4
Private stock cars on Company's lines.....	93	80	77	77	81.7
All classes of cars on Company's lines.....	..	..	..	30.5	...

* In Wellington's "Economic Theory of Railway Location," page 168, the following figures are given for average car mileage for about the year 1885. Though on a somewhat different basis, they indicate that the average mileage of various classes of cars has not greatly changed since that day:

	Miles per day.	Miles per year.
Coal and flat cars.....	15 to 20	5,000 to 7,500
Box cars.....	25 to 40	9,000 to 15,000
"Line" cars.....	70 to 100	25,000 to 35,000
Average.....	35 to 45	12,000 to 16,500

The use of private cars is a practice which has had its chief growth in the five years since this book was published.

Figures taken from the book of one of the largest and most important private car companies show that during 1890 its cars averaged about 48,000 miles. The general manager of a private stock line said that the demand for private cars was such that he had been able to average more than 100 miles per car per day for his entire equipment during the past six months.

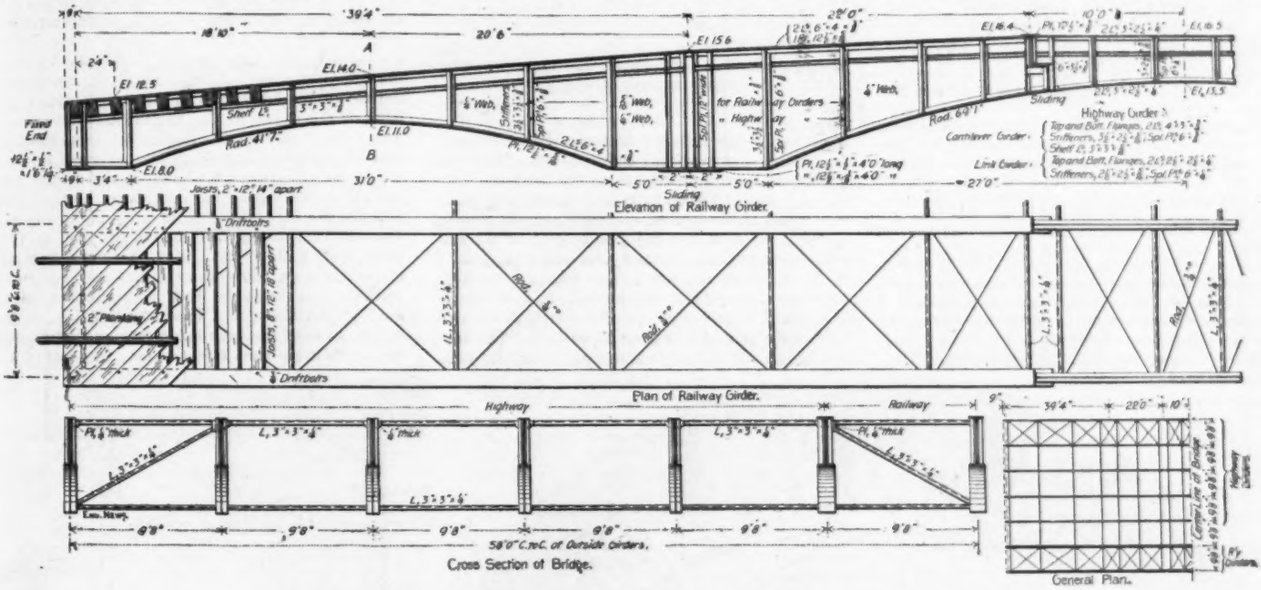
The evils resulting from the use of private cars are recognized and severely condemned by railway officers, but they are unable to do away with it at present. The following letter from the general manager of a prominent Western railway will show the attitude of the railways toward this abuse:

"Individually, there is no more able man than the average railroad manager. It is a position which requires constant mental activity and a very high order of ability. Collectively, however, the railroad managers of this country are guilty of things which entitle them to places in asylums for the hopelessly insane. An instance of this is the incubus of private cars which now affects most of the railroads in the country, but bears particularly hard upon the Western railroads, which are large carriers of live stock and of products ordinarily shipped in refrigerator cars. No more profitable business has been known in this country for many years than has been enjoyed during the past decade by the owners of so-called palace stock cars. Previous to ten years ago these were comparatively unknown, but about that time they were introduced for alleged humane reasons. They were provided with racks for the storage of hay, and troughs for water, and it was held that stock could be run long distances and fed and watered en route, thus rendering it unnecessary to stop and supply food and water to cattle in case of inability to reach regular feeding stations. This was the pretense upon which the cars were originally put into use, but it was only a pretense. As a matter of fact, the watering facilities are almost never used, and the feeding facilities in the cars are unnecessary. The law of the United States provides that live stock must not be kept in transit for more than 28 consecutive hours, except in cars provided with feed and water facilities. These cars, it is true, were provided with alleged facilities for watering cattle, but they are never or rarely watered, and the result is that they arrive at destination so thirsty that they drink a vast quantity of water, which is subsequently sold as beef, the object being to increase the weight of the cattle. Thus nothing is gained by the so-called palace stock car from a humanitarian point of view.

The demand for these cars became so great, however, that the railroads one after another capitulated and made contracts running from three to five years with the various owners of so-called palace stock cars. By reason of the quick trips and the consequently large mileage of these cars the investment on the part of the owners became exceedingly profitable; so profitable that many of the largest shippers, seeing how much money was being made from the use of stock cars, invested in cars of their own, and thus obtained an enormous return upon the capital so invested, aside from their legitimate profits as cattle dealers.

The palace stock cars are absolutely without benefit to the railroads, but are a direct injury and loss, inasmuch as the ordinary live stock equipment is on most roads relegated to the side tracks or to carrying the cheaper articles of merchandise, like lumber and coal. It is no longer possible to ship cattle from the West to Chicago in common stock cars and return the same car loaded with lumber, because the shipper demands a palace car and the owner of the latter refuses to allow it to be sent out of its route for a load of lumber, but insists upon its being returned to the original shipping point or to some other point where it can be again loaded with cattle. This results in a large empty mileage on which the railroads have to pay the same as on the load.

As to refrigerator cars, the burden on the railroads is still heavier, owing to the fact that in an evil hour some of the roads consented to the payment of an



DETAILS OF STEEL BRIDGES OVER THE CANAL; WORLD'S COLUMBIAN EXPOSITION.

exorbitant mileage upon the theory that these cars were more expensive and that they were in the nature of a special equipment, which the railroads could not furnish. There was originally a grain of truth in this, because the demand for refrigerator cars sprang up suddenly and found most of the railroads unprepared to meet it. They were unwilling to invest large sums in the construction of refrigerator cars, and consequently accepted those furnished by the shippers. Indeed, it was at one time almost necessary to the success of the dressed-beef and packing-house business that the shippers should furnish this class of equipment, the railroads being unable or unwilling to invest the necessary amount for that purpose. There was, therefore, originally some excuse for the ownership by private individuals of refrigerator cars and their use by the railroads upon a mileage basis. There was never any reasonable excuse for the increase of the mileage from three-quarters of a cent to one cent per mile. It is true that a refrigerator car costs perhaps $250 more than the average box car; it is also true, however, that it is very much heavier, and as the railroads haul the extra dead weight without compensation, and, as in nine cases out of ten, a refrigerator car is hauled in one direction empty, while box cars can be loaded anywhere, and as, moreover, the refrigerator car is always loaded with perishable freight upon which the railroads are obliged to make quick time, thus securing an enormous return in mileage to the shipper, the original rate of three-quarters of a cent was more than ample to pay a very large return upon the investment in these cars.

These two species of special equipment, namely, the refrigerator car and the palace stock car, are two of the greatest vampires that are now sucking the life-blood of the railroads. Perhaps the present state of things is merely an incident in the evolution of the transportation business. Perhaps they are evils which might have been expected and which could not be avoided. I believe that there is now a general disposition to avoid them both in the future, and that as soon as certain unfortunate contracts expire there will be a determined effort to get rid of the incubus.

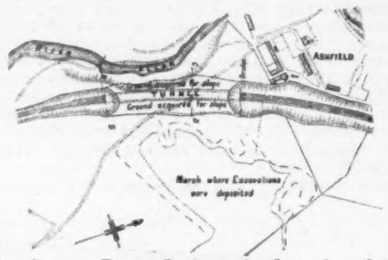
Another general manager, writing in a similar strain, estimates that the 20,000 palace stock cars now in use will earn $2,700,000 per year in mileage, and that this amount represents the increased net earnings the railways would derive from the use of their own cars in place of these.

In view of these facts, the committee recommended amendments to the Interstate Commerce law, prohibiting the allowance of mileage for the use of private cars beyond a reasonable compensation for the car when loaded, no mileage to be paid on the empty car. It should be also made plain that giving free transportation to persons connected with private car lines is contrary to the law as at present constituted; and that railway companies who permit private freight cars to be hauled in their trains, must at the same time furnish equally good cars to meet reasonable requirements of other shippers. A statutory provision empowering the Interstate Commerce Commission to determine what is a reasonable car mileage rate was also recommended.

The committee on harmony in railway legislation reported that a conference of all the New England Commissions was held in Boston, Dec. 11, 1891, at which a compilation of the general railroad laws of the New England states and New York was recommended. The states of New York, Massachusetts, Pennsylvania, Michigan, New Jersey and Delaware have passed acts for the appointment of commissions devoted to securing uniformity of laws. It was proposed that the convention should by resolution recommend the passage of similar laws in each state. The resolution was adopted.

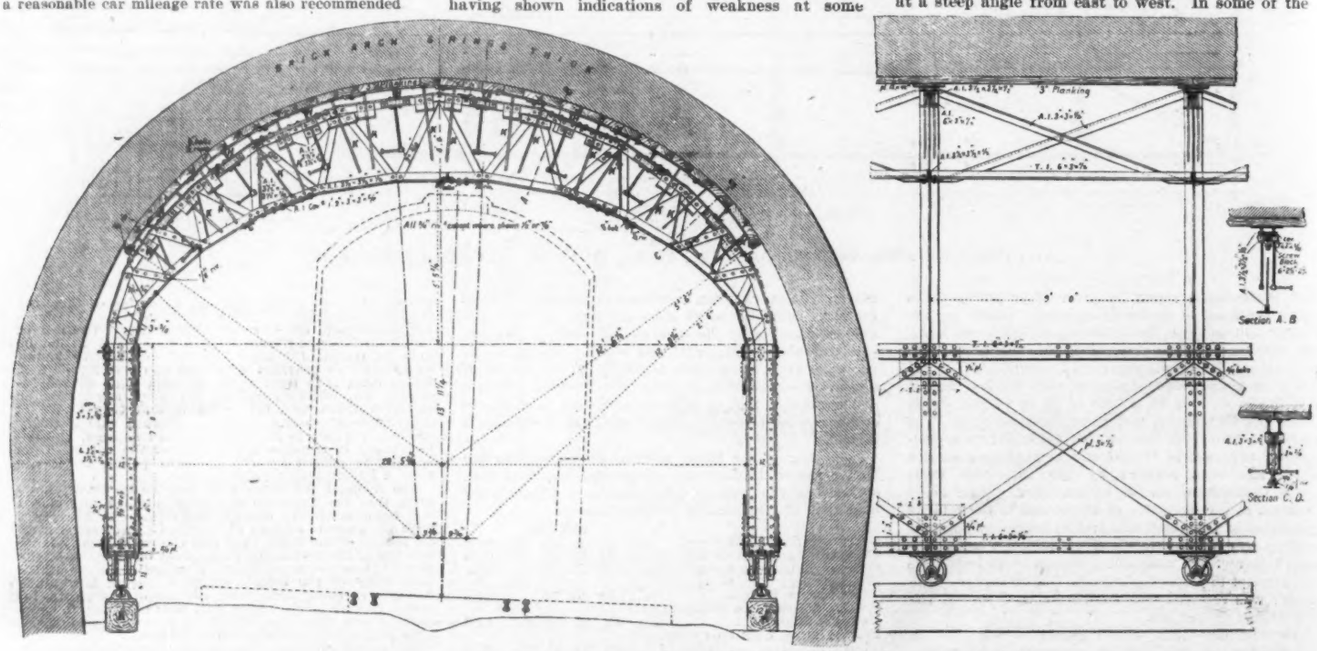
REMOVAL OF A TUNNEL; CALEDONIAN RAILWAY, SCOTLAND.

The Caledonian Railway, of Scotland, has substituted an open cut for a tunnel 780 ft. long, on its main line, the work being carried out without interfering with the traffic. The following description and illustrations are taken from an article in "Engineering." The tunnel was about six miles north of Stirling, and was built 40 years ago. The width was 25 ft. and the height from rail level to crown varied from 17 ft. 6 ins. to 20 ft. At some parts of the side walls, freestone rock occurred and was dressed to carry the arch, but the greater part of the side walls were built of masonry to a height of about 4 ft. 6 ins. above rail level. The arch was built of six rings of brick, and was about 2 ft. 6 ins. thick. The height from the crown of the arch to the surface of the ground was from 30 to 44 ft. The arch having shown indications of weakness at some points, it was decided to open up the tunnel, and the necessary powers were obtained from Parliament, and arrangements made with land-owners for depositing the excavated material on a marsh in a hollow near the tunnel, thus allowing of excavating all the material without interfering with the railway traffic. A traveling iron shield was designed to be placed under the brick arch while it was being removed, after the earth had been excavated from above, and in order to allow this shield to be placed the double-track line was gantleted, giving about 10 ins. between the rails of each track. This arrangement avoided the use of facing switches or movable parts, and the section from a permanent signal cabin near the south end of the tunnel to a temporary cabin near the north end, a distance of 1,830 ft., was worked as a single track line on the electric train tablet system.



Map Showing Tunnel Replaced by Open Cut; Caledonian Railway, Scotland.

A contract was let to A. H. Boyle, of Glasgow, for excavating and depositing 121,350 cu. yds. of material, erecting a bridge with three steel girder spans and masonry piers, diverting a road, and doing other contingent work. The excavation was begun at the north end of the tunnel, temporary tracks being laid from it to the dump, along which the dump cars were run by a contractor's locomotive. When sufficient space was cleared over the tunnel mouth, a steam excavator was brought into use, the work being simultaneously carried on by carts at the higher places in advance of the excavator, reducing these to 10 or 12 ft. in height. The excavator made a cut about 20 ft. deep, and the full width of the sweep of the arm, over the middle of the tunnel from north to south, and then made two other runs over the tunnel, widening the excavation approximately to the full width. When this was done, an inclined track was laid from the surface at the north end down the east slope of the cut, the dump cars being hauled up by a stationary engine and wire rope. From the bottom of the incline tracks were laid along the cut to the north end of the tunnel and the material excavated, laying bare the top of the brick arch to about 7 ft. below the level of the crown at the haunches. This method was carried on until the excavation approached so near the south end that there was not room to work the dump cars, when a steam derrick crane was erected at the top of the east slope, at the south end, and the cars hoisted by it to the top of the cut. The materials varied from fine sharp sand to very hard, stiff boulder clay, with numerous boulders of various sizes, some so large that they had to be blasted. Soft freestone rock was encountered at some places, rising to a considerable height at the slopes, some of the beds being thin and all dipping at a steep angle from east to west. In some of the sand beds a good deal of water was met with, and was conveyed in drains to the side of the track.



SHIELD USED IN REMOVING TUNNEL ARCH; CALEDONIAN RAILWAY, SCOTLAND.

The iron shield was 63 ft. long, so that about 60 ft. of the arch could be removed at a time. It was carried on grooved wheels 12 ins. in diameter, 9 ft. apart, running upon a track of bull-head rails in cast iron chairs fastened to 12x12-in. longitudinal timbers. The shield was built up of plates and angles, and consisted of transverse ribs or trusses

The report of the committee on Reasonable Rates was prepared by Judge W. B. Fleming, of Kentucky, and was an able document, discussing the question from both the legal and the practical standpoint. It was recommended that the amendments to the Interstate Commerce law, which have already been asked for by the Commission intrusted with its administration, be granted, viz.: "That the Commission's findings be accepted as conclusive in proceedings before the courts."

placed 9 ft. apart and braced together. The wheels were placed under the bottom of the ribs, as shown. When run into position under the arch, the shield was lifted by jacks till the top was against the brickwork, the bottom of the shield being then supported on timber blocks keyed up to take all the weight off the wheels and axles. The iron plates (E), upon which the timber lagging rested, were then raised by the screws (H) until all the planks were pressed hard against the brickwork, and the plates (E) then blocked with timbers on the arched rib to take the weight off the screws. The shield was then ready for the breaking up of the arch at the crown and removing it as far as the side walls, which were left to act as retaining walls for the slopes of the cut. When a section had been removed, the blocking was withdrawn from the arched ribs, the plates and lagging lowered by the screws, the blocks removed to lower the wheels onto the rails, and the shield run forward another length. The varying height of the arch presented a difficulty, there being several breaks in the roof, at some of which the versed sine of the arch varied as much as 2 ft. 6 ins. To meet this difficulty the iron plates (E), carrying the wooden lagging, were made in lengths of about 3 ft., with overlap slip joints, fastened by bolts (K) passing through slotted holes, allowing sufficient play for the lagging being accommodated to the varying sections of the tunnel arch. Rails were laid above the arch, one on each side, to carry a movable staging on which a derrick crane was fitted by which the bricks were lifted and loaded into the cars.

The steam excavator commenced work in August, 1889, and the shield was put in place Oct. 12, 1890. The first length of 63 ft. of the arch was removed by Oct. 23, the second by Nov. 1, and this work was completed on March 6, 1891. The line was worked as single track from Oct. 12, 1890, to March 29, 1891, and men were engaged in dressing the slopes of the cut until May 30, 1891. The masonry side walls were left in place, and covered with a coping of 6 ins. of concrete, against which the bottoms of the slopes were dressed. The work was designed by and carried out under the supervision of Mr. T. M. Barr, Division Engineer. The total cost was about $50,000.

NOTES ON IRRIGATION.

Until recently scientific irrigation on a large scale in the United States was practically unknown. Within the last few years engineering skill has been largely sought in connection with irrigation works and gradually improved methods of construction and operation are being introduced. The irrigation engineer, however, finds, or has found until recently, that he must look abroad for many of the data required for the solution of his problems. The following notes have been sent us by Mr. H. M. Wilson, of the U. S. Geological Survey. While most of the information given may be found in the publication of that survey, it will doubtless be new to many of our readers.

Mr. Wilson calls attention to the lack of information upon which to base estimates of the amount of water that can be obtained or made available for irrigation in connection with any project. He says that it is very desirable to have approximate values of the percentage of run-off of the various catchment basins in order that, in connection with the rainfall shown by the observations of the Weather Bureau, approximate estimates may be made of the discharges of the streams. As a result of the inquiries made by the engineers of the U. S. Geological Survey in 1889 and 1890, says Mr. Wilson, it was discovered that in eastern Nevada at the head waters of the Truckee River the average depth of run-off was 19 ins., while the run-off at the heads of the minor forks of this river in the higher Sierras averaged about 50 ins. This is equivalent for the whole of the Truckee River basin to a run-off of about 45 per cent. of the precipitation, and on the higher branches where the slopes are steeper and the surface more rocky to a run-off of about 65 per cent. Similarly at the head waters of the Carson and Walker Rivers the run-off on the mountain catchment basins averages in all 65 per cent. of the total precipitation. In Colorado, on the upper Arkansas River drainage basin, similar results were obtained, the depth of run-off averaging about 20 ins., or 66 per cent., where the total amount of precipitation averages 30 ins.

Regarding evaporation and seepage, Mr. Wilson states that experiments to determine the losses due to these causes have given us some results on which to base calculations, but these are very meager. Further and full experiments must be conducted either by private parties, agricultural experiment stations or the government. The volume lost by evaporation varies greatly according to the locality. In the most northern portion of the arid regions, as Montana, the annual depth of evaporation varies between 32 ins. in the more northerly portions of the state near Great Falls, to 36 ins. in the lower and warmer regions along the Yellowstone River and in the Gallatin Valley. In Colorado the depth of evaporation varies with the altitude, being as low in the higher portions of the Rocky Mountains in some places as 3 ft., and reaching 4½ to 5 ft. on the lower plains in eastern Colorado. In Arizona and New Mexico the evaporation is proportionately greater, reaching from 5 to 6½ ft., and at El Paso, where prolonged records have been kept, it is as high as 7 ft. The State Agricultural College of Colorado is fortunately doing some good work just now in the way of making observations for evaporation. Tanks have been placed in the college grounds and in the San Luis Valley, and if these observations are kept up for a period of years doubtless some good results for these localities will be obtained.

From estimates made of the evaporation in Montana and in California, it was discovered that the losses by evaporation and seepage from reservoirs averaged about 10 per cent. of the full capacity, rarely exceeding this figure if the reservoir had an average good depth, and some times falling below when the depth was relatively great. Of course, with extreme and shallow reservoirs the percentage of loss will be much greater.

There is usually more loss of water from seepage in earthen canals than from evaporation. In every canal, through sandy loam, the loss by absorption at first is very serious. Gradually the ground gets saturated, and at the same time the interstices of the porous material of the bed and banks get filled up with particles of clay, which diminish the percolation.

While the loss of water from seepage is great, ranging, according to Mr. Wilson, from 20 to 70 per cent., according to newness and length of the canals and other varying conditions, yet it is also true that canals or streams running through irrigated areas receive back some of the water previously lost. On this point Mr. Wilson says that experiments and measurements to prove this were instituted in Colorado in 1885 by Mr. E. S. Nettleton, State Engineer, and were continued by him when opportunity offered for several years. These experiments were carefully conducted, and some interesting data have been secured as a result. On the Cache La Poudre River, starting with a discharge of 127.6 sec.-ft. in the canyon before any water was drawn in the canals, the volume at a point considerable lower down on the stream near the town of Greeley, had increased to 214.5 sec.-ft. after supplying 15 canals; showing the addition of more than two-thirds of the original volume to supply canals further down the valley. Other experiments conducted by Mr. Nettleton in 1889 indicated that as much as 80 per cent. of the water used in irrigation was returned to the river lower down after it had performed its duty in irrigating the lands.

As early as 1874 the withdrawal of large quantities of water from navigable rivers for purposes of irrigation caused some alarm in California, as it was feared that it might result in diminishing the depth of water in the Sacramento and San Joaquin Rivers. A Board of Commissioners, consisting of Col. B. S. Alexander and Major George S. Mendel, of the Engineering Corps of the U. S. Army, and Prof. George Davidson, of the U. S. Coast Survey, was appointed by the President to examine into the possible effects of irrigation on the navigation of these rivers. These officers reported that the amount of water finding its way back to the rivers by means of seepage after it had been used in irrigating the lands is so great that a comparatively few miles below the head-gates of the canals large volumes of water may be expected to appear again in the stream.

THE CAST IRON PIPE INDUSTRY.

In Census Bulletin No. 168, Dr. William M. Sweet deals with the cast iron pipe industry in the United States. The statistics of the industry for 1890 are given in the following table:

States.	No. est'b-lishm'ts.	Capital invested.	Av. No. hands.	Wages paid.	Cost of materials.	Value product.
New York and the New England states	3	589,463	338	163,244	292,361	516,421
New Jersey	6	4,543,204	2,298	1,217,813	3,105,401	5,032,571
Pennsylvania	a8	1,390,107	711	341,659	979,685	1,491,805
Southern states	8	3,561,162	2,024	937,141	2,250,258	3,714,203
Ohio	4	1,050,311	1,004	550,054	1,405,425	2,189,565
Other Western states	7	2,266,686	1,323	584,490	1,444,259	2,224,027
Total	a36	$14,300,933	7,788	$3,794,407	$9,483,389	$15,168,682

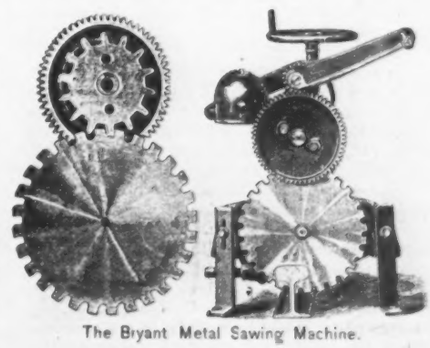
a Includes 2 establishments reporting $68,500 capital, which were not in operation during the census year 1890.

Eastern Pennsylvania and New Jersey have the larger and older establishments, one of these, at Millville, N. J., having been in operation since 1803. These Eastern pipe foundries produced 43 per cent. of the total output in 1890, and until quite recently they supplied the demands of nearly the whole country. But the advance in municipal improvements in the West and Southwest, the development of the iron industry in these sections, coupled with the cost of transportation, has resulted in the establishment of large plants nearer to these markets. Of the thirty-six establishments reported in 1890, twenty have been built since 1880.

A total of 513,030 tons of cast iron pipe was made during 1890, of a total value of $12,556,315. New Jersey is credited with 185,510 tons of this product, and the Southern States with 128,253 tons. Ohio comes next with 73,734 tons, and Pennsylvania made 48,460 tons. New York and the New England States only made 13,066 tons, and the Western States, other than Ohio, made 64,007 tons. The total value of other castings than pipe was $1,802,679, with this amount about evenly divided among the several states and groups of states above mentioned, New York and New England excepted. Since the close of the census year six new pipe foundries have been started, one in Virginia, four in Alabama and one in Texas.

THE BRYANT METAL SAWING MACHINE.

The Bryant metal saw here illustrated is portable, and its makers claim for it that it will cut any rail, for street or railway purposes, in ten minutes. They give records showing the cutting of a 60-lb. rail in 3 min., a 95-lb. rail in 3 min. 25 sec., and a 72-lb. rail cut at an angle of 35 degrees in 7 min. This saw occupies a space of about 2 by 6 ft., and



The Bryant Metal Sawing Machine.

is worked by two men. For heavier work a saw of about 1 HP. is made that is claimed to have cut a 15-in. I-beam, straight or at an angle, in 6 min.; and a 9-in. shaft in 13 min. These saws are adjustable anywhere between 45 degrees and 90 degrees.

The saw blade and the mode of transmitting power to it are peculiar to this machine, as shown in the cut given. For rapid work the saw blade is limited to seven revolutions per minute. Various types and powers of this saw are sold by the Q. & C. Co., Chicago, Ill.

THE ENGINEERING SCHOOLS OF THE UNITED STATES.

VI.

(These papers will be republished in book form, and corrections or proper additions are solicited, and can be made at any time. It is especially desired to make the list of schools claiming to be engineering schools absolutely complete. The temporary use of printed or other documents relating to the early history of engineering schools founded prior to 1850-55, and showing the motives and plans of the founders, early course of study, conditions for graduation, etc., is solicited. Any documents thus loaned will be promptly returned uninjured.)

EARLY ENGINEERING SCHOOLS.—RENSSELAER POLYTECHNIC INSTITUTE.

The first engineering graduates from any civil engineering school (excepting two or three governmental schools on the Continent of Europe) were graduated from the Rensselaer Polytechnic Institute in 1840. A brief review of the conditions of engineering practice prior to that date will show why, in this country at least, it was not possible to support a civil engineering school at an earlier date.

The railway interest, which now gives employment to very much more than half of the active body of the profession, as we shall see, then hardly existed. The first railway completed in this country was 28 miles and was opened in 1830.* Up to (and including) 1835, only 1,098 miles had been completed. At the end of 1840 only 2,818 miles had been built. While many more engineers in proportion were required then than now, this did not give employment to any large number of engineers, and about that time there was an all but complete cessation of canal construction, which had heretofore been the only great field for or school of engineers, setting free a good many engineers who turned to railway work. That canal work had been for a long time a pretty good field for a limited number of engineers is shown in the following Table VIII. which we have compiled from the information given in a special report on canals for the 1880 census. As no similar table has ever been compiled before, to our knowledge, it is worth a little study.

The canal era proper began in 1817 with the beginning of work on the Erie Canal. Table VIII. shows by half decades (chiefly) the total number of miles of canal on slackwater navigation on which work had been started, and how much of this had been abandoned in 1880 or was still in use. Since 1880 about a fifth of the canal mileage which was then in use has been abandoned.

Table VIII.—Showing the Total Miles of Canal or Slackwater Navigation in the United States Begun in Each Half Decade or Decade.

Construction started.	Existing in 1880. Canals.	Slackw.	Abandoned. Canals.	Total. Started.
Before 1820	639	81	74	824
1821–25	753	20	101	874
1826–30	686	19	238	943
1831–35	51	...	1,026	1,077
1836–40	218	222	463	903
1841–50	87	39	....	126
1851–60	14	30	18	62
After 1860	23	...	....	23
Unstated	14	...	34	48
	2,515	411	1,954	4,880

It is a striking feature of this table that nearly all our canals which were still in use in 1880 (2,108 out 2,515 miles) had had work started on them before 1830; in other words, had been begun so early that it was impossible for them to have their (otherwise) natural stimulating effect upon the foundation of engineering schools. The country was then too raw and new. The very conception of a civil engineering school had not yet arisen. The very word "engineer" had not yet come to mean anything in popular thought except a military officer. The phrase "civil engineer" had been but lately coined, and when the Institution of Civil Engineers was incorporated in England, in 1828, had a new and strange ring even then, and its assumption by civilians was somewhat resented by military engineers. James Brindley, perhaps the greatest canal engineer who ever lived, had never dreamed of styling himself a civil or any other kind of engineer when he died in 1772. The word then had a purely military signification.

Therefore it was natural enough that the first notion that civil engineering was to become so important a feature of modern life as to require special school for training civil engineers should have come in, as it did, with the rise to prominence of the railway system. This was especially true be-

* The trial of the Rocket was on Oct. 6, 1829, and the Liverpool & Manchester Ry. (31½ miles) was opened to traffic in 1830. In this latter year also John B. Jervis invented and applied the locomotive swiveling truck.

PREPARATION BRANCH
Recently established at RENSSELAER SCHOOL.

From a respect for the frequent solicitations of many gentlemen in the Southern States, and of some in the Northern, and from a desire expressed by the patron, to see the results of an extension of his plan, a *preparation branch* was this day established at this school, to go into operation on the third Wednesday in November.

The following is an outline of the Plan.

1. The original method of instruction which has produced such unexpected results, called the Rensselaerean method, will be extended to this branch; to wit, that of exercising the student, on the forenoon of each day, by causing him to give an *extemporaneous dissertation* or *lecture* on the subject of his course, from concise written memoranda; and to spend the afternoon in *scholastic amusements*.

2. The circle of instruction is divided into five parts; and to each part is attached a course of *summer* and *winter* afternoon amusements. The following order will be observed in the fall and winter terms. In the spring term it will be inverted.

First Division. BOTANY and ETYMOLOGY. (The latter branch will extend to so much knowledge of the structure of the Latin, Greek, and French languages, as will enable the student to trace scientific terms to their themes, which are derived from those languages.) AMUSEMENTS. For *summer*. Collecting and preserving minerals, plants and insects. For *winter* none, as this division will not be studied in the winter.

Second Division. GEOGRAPHY and HISTORY. AMUSEMENTS. For *summer*. Selecting specimens for illustrating the physiology of vegetation, and examining them under the common, and the solar, microscopes, and making drawings of their internal structure. For *winter*. Each making a globe of plaster of Paris, and drawing the chief subjects of geography upon it.

Third Division. Elements of PRACTICAL MATHEMATICS and of MORAL PHILOSOPHY. AMUSEMENTS. For *summer*. Land-surveying, taking the latitude, and performing simple hydraulic experiments. For *winter*. Making and using a set of mechanical powers, exercises in percussion with suspended balls, gauging, measuring cordwood and timber.

Fourth Division. LOGIC and RHETORIC. AMUSEMENTS. For *summer*. Experimenting upon the most common gases, as oxygen (obtained from vegetables by the action of light) nitrogen, hydrogen, carbonic acid (with its combination in soda-water) testing their specific gravities, &c. and experimenting upon aqueous exhalations—all to be performed with apparatus made with their own hands. For *winter*. Making and using galvanic batteries and piles, electrometers and magnets; and disengaging combined caloric by compression and affinity.

Fifth Division. Elementary principles of GOVERNMENT and LAW, and PARLIAMENTARY RULES. AMUSEMENTS. For *spring* and *fall*. Constructing dials, fixing meridians, constructing and using air-thermometers and hygrometers, taking specific gravities, using the blow-pipe and constructing the three elementary musical chords to illustrate the science of tones. For *winter*. Making camera-obscura boxes; producing focal images by a pair of common burning glasses and ice lenses, and illustrating the microscope and telescope by the same; illustrating the laws of refraction and reflection by cheap mirrors and vessels of water, and separating the coloured rays by ice cut into triangular prisms.

Candidates are admitted to the preparation branch, who are deemed of sufficient discretion for going through the course, provided they have been successfully taught in reading, writing, common arithmetic and English grammar. The Faculty of Rensselaer School are to judge upon their qualifications; but the Trustees have, in the second article of the by-laws of this branch, expressed an opinion, that "the age of thirteen or fourteen years and upwards, is best adapted to this course."

EXPENSES. *Tuition* $1 50 cents for every three weeks, which constitutes a step in the circle. Students may enter either step in the circle at the commencement of every three weeks, reckoning from the beginning of each term. The terms or sessions of this branch, correspond with the other terms of the School. *Board*, in commons with the other students, never to exceed $1 50 per week. Rooms will be furnished at or near the school, to be under the inspection and controul of the faculty, at a small expense. No charge is made for the use of public rooms, library, chemical and philosophical apparatus, tools of the workshop, or the cabinet. And each student will attend the daily lectures of the Professors, free of charges. A student of strict prudence, may pay all his expenses for the 42 weeks in each year, at this branch, with $120, as follows: Tuition $21: board $63: fuel and lights $10: washing and lodging $10: text books $6: amusement apparatus, $10.

As this circular may fall into the hands of some, who have not read the new code of by-laws, passed April 3d, 1826, and the legislative act of incorporation, passed March 21st, 1826, it may be advisable to state as follows:

The Rensselaer School was founded by the Honorable Stephen Van Rensselaer, solely for the purpose of affording an opportunity to the farmer, the mechanic, the clergyman, the lawyer, the physician, the merchant, and in short, to the man of business or of leisure, of any calling whatever, to become *practically scientific*. Though the branches which are not taught here, are held in high estimation, it is believed that a school attempting every thing, makes proficients in nothing. The Rensselaer School, therefore, is limited to an EXPERIMENTAL COURSE in the NATURAL SCIENCES. The studies of the preparation branch are extended no farther than is necessary, as auxiliaries to the experimental course.

The FALL TERM commences on the third Wednesday in July, and continues 15 weeks.

The WINTER TERM commences on the third Wednesday in November, and continues 12 weeks.

The SPRING TERM commences on the first Wednesday in March, and continues until the last Wednesday in June; which is the day of the annual commencement.

EXPENSES. All the same as in the preparation branch, with the addition of double the charge for tuition in the fall and spring terms, on account of the great additional labor required for teaching the student to perform with his own hands about sixteen hundred experiments in chemistry and natural philosophy. But students who have gone through a course in the preparation branch with success, will not be required to attend the winter term. This will reduce the necessary expenses to about $95 for the whole experimental course.

Many unsuccessful attempts have been made to render science amusing to the youthful mind. They have generally proved very unprofitable, by diverting the attention of the student from literary pursuits, and by creating an attachment to useless, and often demoralizing sports. By the plan adopted at this school, the objections to scholastic amusements are effectually obviated; and it will appear by this circular, that those have been selected, which will give due exercise to both body and mind. The muscular powers of the body will be called into action, and their forces will be directed by mental ingenuity, until the student becomes familiar with the most important scientific manipulations, and particularly with those which will be most useful in the common concerns of life.

The Rensselaerean scheme for communicating scientific knowledge had never been attempted on either continent, until it was instituted at this school, two years ago. Many indeed mistook it, at first, for Fellenberg's method; but its great superiority has now been satisfactorily tested by its effects. As the *experimental school*, as well as the *preparation branch*, were founded solely for the public benefit by its disinterested patron, it is the particular desire of the trustees, that its excellences should be understood and imitated at other schools, as set forth in a former circular. Like other useful inventions, much expense was required for making the first experiment. Fortunately for science, the trial has been fairly made at the expense of many thousands, advanced by a single individual. Now it may be followed, in its chief advantages, by every school district; while the parent school at Troy will prepare competent teachers.

By order of the Trustees.

Rensselaer School, Troy, (N. Y.) Sept. 14, 1826. SAMUEL BLATCHFORD, *President.*

OFFICERS OF THE SCHOOL.

PATRON,

Hon. Stephen Van Rensselaer, with the power to appoint all Examiners.

TRUSTEES,

Surveyor Gen. S. De Witt and Prof. T. R. Beck, of Albany—Hon. J. D. Dickinson and Hon. R. P. Hart, of Troy—Rev. Dr. Blatchford and E. Parmelee, Esquire, of Lansingburgh—Hon. G. Van Schoonhoven and Hon. J. Cramer, of Waterford.

FACULTY,

Rev. S. Blatchford, President,—A. Eaton, Sen. Prof.—L. C. Beck, Jun. Prof.

AUXILIARY OFFICERS,

Dr. Moses Hale, Sec'ry.—Mr. H. N. Lockwood, Treas.—T. Dwight Eaton, Monitor and Librarian,—Asahel Gilbert, Steward,—Cyrus A. Lockwood, Esquire, Acting Steward.

FAC-SIMILE OF THE FIRST PROSPECTUS OF THE RENSSELAER SCHOOL AND ITS "PREPARATION BRANCH," 1826. THE FIRST PROSPECTUS OF A SCHOOL OF SCIENCE EVER ISSUED IN ENGLISH.

cause, after 1830, canal building in the East was greatly checked. Most of the canal work which was started between 1830 and 1840 was in what were then the wilds of Ohio and Indiana, and has since been abandoned. Canals could not, like railways, be indefinitely multiplied, and there was every reason to believe, therefore, that canal construction would soon begin to fall off in this country, as it already had in England, where some 4,700 miles had been constructed.

Rather from a sense of the importance to mankind of science generally than with any idea of founding a school for civil engineers, therefore, the Honorable Stephen Van Rensselaer (would that every man so well deserved the title) founded at his own sole expense the "Rensselaer School" in 1824-5 The first printed copy of the act of incorporation, passed March 21, 1826, and accompanied by the constitution and laws of the school for the same year, lies before us as we write, and it is significant that the word "engineer" or "engineering" does not appear either in the bill of incorporation, or in any part of the pamphlet of 46 pages. It had not yet become a part of the living tongue, except in a military sense. But in another pamphlet of 17 pages bound in with this, and printed in 1828 (the first triennial catalogue) the word does appear, it being one of the duties of the senior professor to lecture on "Chemistry, Natural Philosophy, Geology, Land Surveying, and Civil Engineering," the last three words having been added to the requirements as stated in the founder's letter in 1826, which became the constitution of the school. There are also three or four men in the 1828 catalogue who are said to be "civil engineers" or "students of civil engineering."

Almost simultaneously with the legal establishment of the Rensselaer School came the establishment of a "Preparation Branch." A broadside describing this last, and also, in its later half, describing the Rensselaer School, is reproduced photographically herewith, slightly reduced from its original size. It is believed to be the first prospectus of a school of practical science ever issued in the English tongue. It refers in its text to the pamphlet to which we have already alluded, as having been previously circulated, but the two must have been in fact printed almost simultaneously.

It will be seen from the description in the "Preparation Branch" circular that the Rensselaer School as first founded, corresponded more nearly to what we now call an agricultural college, than to any modern engineering school; but that the founder intended his school to fill the place now filled by engineering schools so far as he then felt it to be necessary or possible is evident from every line of these early documents. The founder was not of the class of rich men who found colleges only from a vague philanthropic instinct and to perpetuate his name. He had distinct and very original and decided views as to proper methods of instruction, which he took great pains to provide for and enforce at length. His love of thoroughness; his determination that the instruction should be of the best, if there was any, and that the school should take a high rank among the kindred institutions of the world, crops out constantly in his letters and deed of foundation, as we shall see more fully when we come to courses of instruction. He was no common founder and he founded no common school. The cause of engineering education owed much to him indeed.

Much that is interesting and curious in this early pamphlet we must pass over, at least for the present, but the following "Notices and Remarks" will certainly bear reproduction in full, as they not only give a curious table of what it cost in those days to "go to college," but gives a synopsis of some of the then peculiar features of the school, which have since been quite extensively copied.

Board in the commons, procured by the steward, amounts to about $1.50 per week.

Expenses for chemical substances and damages to apparatus depend on the student's own care and prudence. They ought not to exceed two or three dollars for each term.

The expenses for fuel and lights will be much reduced by the late law, establishing fall and spring experimental terms, and omitting experiments during the cold season of winter. See page 10.

The expenses for a student of ordinary prudence will be about $100, if he is absent during the winter term. See By-Laws, Article 4, page 19.

Board, 30 weeks, at $1.50	$45.00
Washing, about 18 cents per week	5.62
Chemical substances, etc., about	4.00
Proportion of fuel and lights, about	6.00
Text books, about	4.00
Experimental term fees, $15	30.00
Total	$94.62

It will be perceived by a perusal of the foregoing constitution and laws, that this school is not the rival of any other. It is even dependent on other schools for the literary polish of its own pupils. It promises nothing but experimental science, taught by a method which perpetually throws the student upon his own mental resources. Its object is single and unique; and nothing is taught at the school but those branches which have a direct application to the "business of living."

Parents who have not governed their sons at home, and inspired them with the principles of sound morality and the spirit of gentlemen, are respectfully requested NOT TO SEND THEM HERE. For the experimental exercises of the school resemble the business of a workshop, in which professors must labor with students, and associate with them as one gentleman associates with another. Consequently students cannot be subjected to that course of discipline, which is practicable at schools organized upon a different plan. No alternative is left for this school but to expel for disorderly or ungentlemanly conduct in a peremptory manner; however desirable it might be to bear with the waywardness of youth, until reformation might be effected by a course of wholesome discipline.

3

tro-Magnetism—inspect the principal Mills, Factories, and other Machinery or works which come within the province of Mathematical Arts; also, study as much Geology as may be required for judging of Rocks and Earth concerned in construction.

Fees for instruction, including all Lectures, Experiments, &c.; also for use of Instruments, Apparatus, Library and Specimens, $4 for each sub-term of four weeks. No student received for less than a sub-term. No extra charge excepting $8 for the course of Experimental Chemistry, where each student gives a course of experiments with his own hands.

Students furnish their own fuel, light, and text-books. Each boards where he pleases; but the Professors will aid strangers in the selection of boarding houses. A small number of strangers are boarded at the School at $2 per week; they furnishing their own bedding, washing, &c.

The Rensselaer degree of Bachelor of Natural Science is conferred on all qualified persons of 17 years or upwards. The Rensselaer degree of Civil Engineer is conferred on candidates of 17 years and upwards, who are well qualified in that department. This power was given to the President, by an amendment to the Charter, passed last session of the Legislature. Candidates are admitted to the Institute who have a good knowledge of Arithmetic, and can understand good authors readily, and can compose with considerable facility.

After a trial of two seasons, it is found to be inexpedient to enter young lads in the regular divisions, before they have sufficient pride of character to govern their conduct when preparing for their exercises in the absence of a teacher; arrangements will therefore be made for having a teacher always present with them, when they are not in the immediate charge of a Professor or Assistant.

Students in any one department have the right to attend one Experimental Lecture each day in the other departments, free of expense.

One year is sufficient for obtaining the Rensselaer degree of Bachelor of Natural Science, or of Civil Engineer, for a candidate who is well prepared to enter. Graduates of Colleges may succeed by close application during the 24 weeks in the Summer term.

Candidates may commence the course at the beginning of any sub-term; but the third Wednesday of November is to be preferred, unless the candidate is a graduate of a regular College, or otherwise well instructed in general Mathematics and Literature. In such cases the last Wednesday in April is the most suitable time of entering. His theoretical views may then be reduced to practice during the Summer course.

4

The degree of Master of Arts is conferred after two years of practical application.

Gentlemen wishing to learn the outline of the terms of the Rensselaer Institute, are requested to pay postage on their letters; and they will receive this printed notice. If this appears to be a "*narrow notice*," I will state that I paid $54,28 in one year in postage for letters on others' business: some for our school course, more for advice about mines, minerals, and visionary projects.

AMOS EATON, *Agent.*

Rensselaer Institute, Troy, Oct. 14, 1835.

NOTICES

OF

RENSSELAER INSTITUTE,

Troy, N. Y., October 14, 1835.

[Being the answer to letters of inquiry.]

HON. STEPHEN VAN RENSSELAER, PATRON, with the right to appoint the Annual Board of Examiners.

ACTING FACULTY.

Rev. E. NOTT, D. D., President—also President of Union College.

Judge DAVID BUEL, Jr., Vice President.

AMOS EATON, Senior Professor, and Professor of Civil Engineering; also holding the Agency and Supervision of the Institute.

EBENEZER EMMONS, Junior Professor.

JAMES HALL, Professor of Chemistry and Physiology.

Assistants—EDWARD SUFFERN and D. S. SMALLEY.

Instruction, wholly practical, illustrated by Experiments and Specimens, is given 40 *weeks in each year.* Five days in each week the forenoon exercises are from 8 A. M. to 1 P. M.

WINTER SESSION commences the third Wednesday in November, and continues 16 weeks. During the first 12 weeks, each forenoon is devoted to practical Mathematics, Arithmetical and Geometrical. This is a most important course for men of business, young and old. During the last 4 weeks of the Winter Term, extemporaneous Speaking on the subjects of Logic, Rhetoric, Geology, Geography and History, is the forenoon exercise. Throughout the whole session the afternoon exercises are Composition, and, in fair weather, exercises in various Mathematical Arts. A course of Lectures on National and Municipal Law, is given by the Senior Professor.

SUMMER SESSION commences on the last Wednesday in April, and continues 24 weeks: ending with Commencement.

2

Students of the Natural Science Department are instructed as follows:

Three weeks, wholly practical Botany, with specimens.

Four weeks, Zoology, including organic remains; and Physiology, including the elements of Organic Chemistry.

Three and a half weeks, Geology and Mineralogy, with specimens.

Three weeks, traveling between Connecticut River and Schoharie Kill, for making collections to be preserved by each student, and exhibited at examinations; also for improving in the knowledge of Natural History and Mathematical Arts.

Ten weeks, Chemistry and Natural Philosophy.

Half a week, preparing for examination and Commencement.

The afternoons of all fair days are devoted to Surveying, Engineering, and various Mathematical Arts—also to Mineralizing, Botanizing, and to collecting and preserving subjects in Zoology.

Students of the Engineer Corps are instructed as follows:

Eight weeks, in learning the use of Instruments; as Compass, Chain, Scale, Protractor, Dividers, Level, Quadrant, Sextant, Barometer, Hydrometer, Hygrometer, Pluviometer, Thermometer, Telescope, Microscope, &c., with their applications to Surveying, Protracting, Leveling, calculating Excavations and Embankments, taking Heights and Distances, Specific Gravity and Weight of Liquids, Degrees of Moisture, Storms, Temperature, Latitude and Longitude by lunar observations and eclipses.

Eight weeks, Mechanical Powers, Circles, Conic Sections, construction of Bridges, Arches, Piers, Rail-Roads, Canals, running Circles for Rail-Ways, correcting the errors of long Levels, caused by refraction and the Earth's convexity, calculating the height of the Atmosphere by twilight, and its whole weight on any given portion of the Earth, its pressure on Hills and in Valleys as affecting the height for fixing the lower valve of a Pump; in calculating the Moon's distance by its horizontal parallax, and the distances of Planets by proportionals of cubes of times to squares of distances.

Four weeks, in calculating the quantity of Water per second, &c., supplied by streams as feeders for Canals, or for turning Machinery; in calculating the velocity and quantity effused per second, &c., from flumes and various vessels, under various heads; the result of various accelerating and retarding forces of water flowing in open race-ways and pipes of waterworks, and in numerous miscellaneous calculations respecting Hydrostatics and Hydrodynamics.

Four weeks, study the effect of Steam and inspect its various applications—Wind, as applied to Machinery; also Elec-

FACSIMILE (SLIGHTLY REDUCED) OF THE FIRST "NOTICE" OF THE "RENSSELAER INSTITUTE," 1835. BELIEVED TO BE THE FIRST PROSPECTUS OF A SCHOOL OF CIVIL ENGINEERING EVER ISSUED IN ENGLISH.

(The first graduates in engineering graduated in 1840.)

In 1827 it was ordered that during each experimental term for $52, and during each recitation term for $32, the students should be entitled to:

Instruction, good plain board, a plain room with two roommates; the use of the library, reading room and instruments, and chemical laboratory facilities. Persons wishing to settle the whole bill in mass, will be entitled to all the aforesaid, together with lodging, washing, mending, private text books, paper and stationery and traveling expenses on two mineralogical excursions of three weeks each, for $230.

Some of the expenses have been increased, but the increased advantages exceed them more than fourfold. The bill of $230 for a year is high, and it is presumed that few will take the course which demands this sum. For a young gentleman of tolerable economy may reduce this to $170, including the expenses of both mineralizing expeditions. But young gentlemen will generally expend $60 more than is necessary if the whole is furnished at a stipulated price.

Times have changed indeed since it was necessary to apologize for $230 as the total bill for all expenses in a year's attendance at college as being "high," and to explain that "the course which demands this sum" was not expected to be taken by any but the wealthy and luxurious, who could afford to get the best; but perhaps even greater changes are yet before us.

Two years later (1828) as already noted, the first distinct recognitions of engineering as engineering, and as a feature of the school, was made. From time to time it became a larger and larger factor, doubtless, for in the meantime, taking canals and railways together, a great rising tide of engineering activity began to come rolling in, which was to culminate in the disastrous panic of 1837. This was not dreamt of in 1835, however, at which time it was first resolved to form a distinct "Engineer Corps," receiving on graduation the "Rensselaer degree of Civil Engineer."

The enlargement of the Erie Canal, on which work began in 1836, may have helped to this decision. The first actual graduates from this corps were in 1840, and the first official announcement of its formation (or at least the first one which "meant business" and resulted in anything) was made in a little four-page circular which surely has historical and curious interest, and which, accordingly, we reproduce in fac-simile, slightly reduced to fit our columns.

We should have stated that there had been from the foundation of the school a senior and junior professor; and it will be observed that the duties of the senior professor, in which "Civil Engineering" did not appear at all in 1826, and only at the tail of a procession in 1828, related to civil engineering only in 1835, a significant and tolerably rapid change. We suppose every one who reads these words will be still more certain to read these circulars all through, and therefore we hardly need allude to the touch of nature at the end of the circular. Postage was postage in 1835, and, alas, salaries were not then salaries, nor are they now, in too many cases.

We subjoin some correspondence and notes relating to the subject matter of these articles.

CORCORAN SCIENTIFIC SCHOOL.

Sir:—I have read with interest your first article, in the issue of 19th inst., of the series on "Schools of Engineering in the United States." Let me congratulate you on the good work you have undertaken. The first attempt may, as you say yourself, not prove wholly complete, but the start once made the necessary material will, I have no doubt, come to you from all sources; and I certainly know of no one better qualified to take this work in hand than yourselves. Statistics are in many cases the forerunner of reform; and reform is what you, in your independent position, are called upon to advocate where it is wanted.

The second object of my letter is to call your attention to the school of engineering, which forms a part of the Corcoran Scientific School of the Columbian University, Washington, D. C. Unfortunately, it is the opinion of the authorities of our university that direct business advertising is not consistent with the dignity of an institution of learning; and to this fact more than to any other is it due that it is but little known outside of Washington, although the very fact of our being located here gives us unsurpassed facilities in the magnificent government material which is at the disposal of our students.

About four years ago it was decided by the committee of the Board of Trustees on the Corcoran Scientific School, in view, I suppose, of applications received, to establish an engineering course as a trial. The Board, however, declined to give the degree of C. E., claiming very rightly that the school was not yet sufficiently organized and equipped for that purpose.

Two gentlemen of high scientific accomplishments occupied the chair of Civil Engineering during that trial period, Professors Woodward and Davis. During the first two years the Trustees of the university consented to give two degrees of C. E. to two students who had taken all but the last year's course at Annapolis, and had satisfactory certificates to this effect, and finished their course here. When Professor Davis left, I was called to fill his place.

I found three students in the course then, two of whom, finding the work too hard, especially in the amount of designing, dropped out, and graduated as B. S. I took occasion then to outline the plan of the school, had the course increased from three to four years, and on the basis of what little advertisement the complaining students had given our new school, we started the new year with five students, four of whom held out to graduation. The year 1890-91 brought more, and 1891-92 was begun with 21 students in the lowest engineering class, second year.

As to the school itself, it must be judged by the results. We had three graduates last year, the Trustees being satisfied with their accomplishments. Of these, one has passed successfully one civil service examination as a constructing draftsman for the Indian Office, and afterward another as iron constructor in the Supervising Architect's Office, which position he still holds, at, I believe, $6 a day. Another of the graduates has presented his graduation thesis to the Engineer Commissioner of the District of Columbia, who offered him, on examining it, any position among his assistants that would become vacant, if he wanted it; the subject of this thesis was a solution of the sewerage problem of Washington, which, as you know, is a burning question.

We expect to have one graduate at the end of this session, and one next year; then it will be the turn of the larger class that has started this year. I believe that our engineering school has a great future before it; that it has already done well in the short time of its existence, notwithstanding the many difficulties it has encountered in the changes of professors, in the lack of understanding of its needs at the beginning, the want of advertising, etc., and we can claim already now a good rank among the civil engineering institutions of the country. Francis R. Fava, Jr.

Washington, D. C., March 18, 1892.

UNIVERSITY OF NORTH CAROLINA.

Sir: I notice in your issue of March 26 that you place this university in class (e) in the list of engineering schools. I regret that you did not receive the detailed report sent with the catalogue. It was filled out as per blank sent in full.

The School of Engineering was only organized (nearly) three years ago, and its four graduates last June were the first. From the catalogue you will see the requirements, text books, hours, etc. The aim has been to make the "quality" of the instruction as high as that of the best technical schools, though in quantity we are behind them somewhat along certain lines; while making up for it by a more general education the first two years, the last two years being almost exclusively technical.

Efforts are now being made to establish a class of engineering distinct from that of mathematics, but at present your humble servant, with an assistant, has entire charge of both mathematics and engineering. Yours very truly.

Chapel Hill, N. C., March 29, 1892. Wm. Cain.

(The report in some way must have gone astray. We regret the error, but rejoice that "mathematics and engineering" are in such good hands, if they must be for the present in only one man's hands.—Ed.)

THAYER SCHOOL OF CIVIL ENGINEERING.

Sir: In your interesting and valuable articles on the Engineering Schools of the United States, the list of schools given in your last issue (March 26) does not give us quite the proper designation. It is easy to see that the "catalogue" of Dartmouth College might mislead a reader as to the status of associated departments of schools here; and your task at best involves so many difficult and delicate questions and adjustments that avoidance of misconstruction in some cases is hardly to be expected. Allow me then to offer a word of explanation as to Dartmouth. In your table on p. 296 we appear as

"23 1-2 Dartmouth (Sci. Dept.).....2."

Now the "Scientific Dept." of the college is the Chandler School of Science and the Arts, an undergraduate course, which confers the degree of B. S. It is a fact that many of its graduates are civil engineers of high standing, which should be noted.

But the Thayer School offers a post-graduate course of two years, having an endowment entirely separate from that of the college or scientific school. It takes students who are already B. S. or B. A. from this or other colleges and gives a strictly professional course on the technique of civil engineering. We supplement work done in the under-graduate courses. In view of these conditions it would be more correct to designate us as "Dartmouth, (Thayer School)" or "Thayer School at Dartmouth College." Very respectfully yours.

Hanover, N. H., March 28, 1892. Robert Fletcher.

(The variety of names which the scientific departments of the various colleges and universities bear is very great. For the purposes of the list to which our correspondent refers, it was deemed sufficient to simply note (Sci. Dept.) after the name of the college, as indicating merely that there was some sort of a scientific department or departments connected with it, from which engineers purported to be graduated. The only exception was, that a number of colleges "of Agriculture and the Mechanic Arts" only purport to graduate mechanical engineers, and in that case that part of the college was designated as the (M. E. Dept.). We shall reach the finer distinctions later.—Ed.)

MASSACHUSETTS AGRICULTURAL COLLEGE.—This college was erroneously located at Worcester instead of Amherst, Mass., in the table published March 26.

SOUTH CAROLINA MILITARY ACADEMY.—This Academy, founded in 1846, and located at Charleston, S. C., should have been included in the same table.

CORNELL UNIVERSITY.—On page 296 of our issue of March 26, first column, second line from bottom, (M. E. Dept.), should read (C. E. Dept.).

SCHOOL OF PRACTICAL SCIENCE.—This school, founded some ten years ago at Toronto, Ont., has recently added a fine laboratory, and should have, perhaps, been mentioned among the leading engineering schools of the Dominion of Canada. As we have stated, however, the scope of these articles on engineering schools does not extend beyond the United States.

UNIVERSITY OF ILLINOIS.—The statistics of engineering schools in our issue of March 26 credited this university with only four graduates in 1889, when there were really nine. The full statistics of graduates of all the engineering schools since there first began to be graduates in 1840, will be published shortly, so that any injustice will be but temporary. We took the figures for that table chiefly from Bureau of Education reports, without referring to our own complete records.

TESTS OF STRUCTURAL WROUGHT IRON AND STEEL.

(Concluded from page 388).

II. The Number of Tests Required.—If the material be steel, of practically one uniform section, and made by a single process, which is reasonably uniform in its operation, one tensile and one bending test for each melt of steel—that is, for each open hearth heat or Bessemer blow—is usually considered sufficient. Should the sections vary or the ingots be of different sizes, requiring more or less work on the steel, each such materially varying section should have a tensile and a bending test. Should there be a suspicion that any portion of the materials has been burned in reheating for rolling or hammering, of course extra tests will be required. A provision incorporated in the Standard Bridge Builders' Specifications by interested parties requires for each contract only four tensile tests, and one additional test for each 50,000 lbs. of material, not taking into account the possible non-homogeneity of the lot thus arbitrarily lumped together. But the absurdity of this device for saving labor and expense has been generally recognized, and it is practically a dead letter in the Standard Bridge Builders' Specifications to-day.

The advisability of keeping melt numbers distinct throughout the manufacture of the material and stamping them upon each of the finished bars has been the subject of considerable controversy. At most of the structural mills, however, it is now deemed important, not only to the inspector, but to the manufacturer, as facilitating the intelligent selection of material from stock on hand, that not only the original ingots but also the blooms and finished material rolled therefrom should be stamped with the melt numbers, and that the records of each melt should be kept so clearly that all required data of quality can be readily ascertained at any subsequent period.

Good open-hearth or Bessemer steel is reasonably homogeneous as cast into ingots in each melt, but the quality of one melt by no means insures that of the next. It follows that the only satisfactory method of testing finished structural open hearth or Bessemer steel (short of the separate testing of every finished piece singly, which is, as a general rule, impracticable) must be based on the melts as the units of quality, and hence that these must be kept separately traceable with the utmost certainty. The advantages of this system should be at once apparent to manufacturers; yet, strange to say, it has been adopted tardily and with reluctance in many works.

The number of tests required for wrought iron is still more difficult to fix. Not only does the raw material vary greatly in quality, but the process of manufacture without fusion does not offer any guaranty of ultimate approximate homogeneity. An inspector acquainted—as he ought to be—with the character of stock used in making iron, the size and make-up of the pile from which the iron is rolled, and the methods of manipulation employed, can often form an intelligent judgment of the metal and dispense with many tests which he would otherwise require. In general, the usual practice is to obtain one tensile, one bending, and one nicked bending test of each materially variant section, mixture of stock, and character of pile in each lot of material of each day's work of the mills. Such tests will average perhaps five or six to the car load, the number varying considerably according to circumstances. Even though the inspector be acquainted with the work and satisfied as to the quality and uniformity of the metal, a certain number of tests for each job is required as a matter of record by the engineer for whom the work is done. Such a record is valuable, not only in case of an accident to the structure in which the material is ultimately placed, but also in question of repairs or of extra loading. In such cases it is essential to have exact data regarding the quality of the material, as developed by the inspector's test. Many parties also insist upon such records for personal vindication of the engineer or the corporation he represents as to the care that has been taken to see that all has been done that could be done to insure good quality in the material furnished.

III. In What Cases More than One Test Should be

Made or Allowed Before Decision is Reached.—This subject has often occasioned much controversy at the mills. It calls for tact as well as good judgment on the part of the inspector, who, if he cannot keep both the respect and the good will of the mill management, has largely lost his usefulness there. Manufacturers claim that where the test-specimen does not fairly represent the material, it is unjust not to allow a second trial upon a fairer specimen. On the other hand, some engineers instruct their inspectors that as the selection and preparation of the test specimen rests mainly with the mill people, the failure to obtain a fair specimen is due to their own carelessness or misfortune, and second tests are not to be permitted. The objection to more than one test, if the first fails, is the difficulty of deciding which represents the material fairly, or of finding and rejecting that part of the lot which the faulty test did represent, and of being sure that there is not more of the same class of faulty material in the lot which will be passed by undiscovered.

The first test sometimes fails because the specimen has been burned or has been cut so close to the crop end as to include a large flaw; or it has been unduly hardened by water on being suddenly plunged into snow or ice in winter while hot from the rolls, as sometimes happens to the ends of bars by careless handling. In such cases it is difficult to decide wisely and justly to both interests. At mills where much trouble of this sort occurs, fast and careless work is being done, and the reputation for this bad work soon becomes known, much to the detriment of the proprietors, who can only regain their prestige by a radical change in their method, which usually includes changes in the mill management. At the same time, a certain amount of it will occur at the best regulated mills. In the practice of the writer, when additional tests are allowed, either the first test specimen must have been manifestly erroneously selected in the judgment of the inspector, or else more than one satisfactory additional test should be made to counterbalance the evidence of the first and to prove that the material is all right. It makes a great deal of difference, of course, what the result of the defective test indicates. If it shows badly burned material or non-homogeneous steel with high manganese (from the ferro-manganese not being properly mixed in it), or brittleness from almost any cause, it is only in exceptional cases, that second tests should be allowed.

The general rule may be laid down that if more than one test is allowed where the first shows metal that should be rejected, it should be only in cases where the defective material represented by the first test can be identified, and where a further series of tests will prove with reasonable certainty there is no more of the defective metal in the lot represented.

Of course if there has been any probability of error in making the test itself, an honest inspector will make a second one, being careful to note all particulars of the verifying test, including the means taken to secure for it a sample as nearly as possible similar in all respects to the first.

IV. The Way in Which Tests Should be Made.—Tests should be conducted with a spirit of fairness to all concerned. With the newer forms of automatic power testing machines now largely used, there is very little opportunity to change the results as recorded by the machines. If the specimens themselves are properly prepared and placed in line in the testing machines, the chances of error are few, and more nearly concern the manufacturer than the engineer. Manufacturers have learned that improperly prepared specimens and carelessness on the part of those who work and keep their tesing machines in order operate most severely against their own interests. It is the present experience of the writer that there is little cause for complaint at the structural mills throughout the country as to the way in which the tests are made.

Kirkaldy strongly recommends determining the tensile strength per square inch of the fractured area, rather than of the original area, as is usually done. He claims for his proposal the advantage of stating the tenacity of the specimen in measures of the ductility of the metal as well, which of itself is a good argument. The matter involves several difficulties, however, beyond that of changing the custom already firmly established. To express the elastic limit in terms of the fractured area would have the disadvantage of not actually showing all the facts regarding the specimen, while to calculate the elastic limit upon the original area and the ultimate strength upon the fractured area would lead to much confusion. Again, a practical difficulty is encountered in accurately measuring the fractured area for this purpose, especially in the case of wrought iron, the metal being liable to open up somewhat at the welds in fracture. Again, specimens sometimes break at other points than that of greatest reduction of area. The disadvantages of the system seem to more than counterbalance any possible advantage.

V. The Interpretation of the Tests and Test Requirements.—It is unreasonable to require the same results from tests of iron or steel made on varying sections, even when the method of manufacture and the general arranagements for producing the crude material are the same. For instance, the same tensile tests should not be required from plate rolled from a given grade, size and shape of ingots into 1¼ in., ⅝ in. and ¼ in. thickness, for the reason that the ¼ in. plate will certainly show evidence of cold-rolling, and the 1¼ in. plate, evidence of not having had sufficient rolling at the low temperature which works the metal to advantage.

It may be remarked here that the use of a small amount of aluminum in the steel will cause the results in these thick specimens to be much more satisfactory, approaching those of ⅝-in. plate. Especially is this the case if some care is taken that in rolling the thicker specimens, the finishing passes are not made at too high a temperature.

Test specimens cut transversely to the longer axis of the material rarely give as good results as specimens cut longitudinally. Especially is this true of iron, which shows a marked decrease in ductility and a very considerable decrease in tensile strength in specimens cut transversely.

Few rejections are made upon the requirement for elastic limit in iron or steel. The usual requirement that the elastic limit for iron shall be 26,000 lbs. per square inch, and for steel that it should be at least one-half the ultimate, is very rarely unfulfilled. The elastic limit is not always a safe criterion of the quality of iron or steel. Many tensile tests show a satisfactory elastic limit which are very low in ductility.

In tests of boiler plate the elastic limit is rarely taken, although this seems to the writer to be an unwise omission. It would be advantageous to have the elastic limit determined, and with the methods of testing usually adopted, it could be approximately obtained with very little trouble and no extra expense.

The elongation in 8 ins. length is the almost universal standard. It was adopted by the English Admiralty as being nearest to the 200 mm. length of the French. Kirkaldy still prefers the 10 in. length. The disadvantage of this length is that it means at least 2 ins. more of length of bars or plates from which test specimens are cut—a matter of no small moment in the large number of tests required in daily practice in structural mills. That a length of at least 8-ins. is advisable, is shown by the increased amount of irregularity in the results obtained with shorter lengths, the irregularities of the elongation and the method of obtaining it at the fracture very considerably increasing the errors in measurements. The old Government marine test-specimen of 1-in. section is now admitted by all to be a manifest error.

The reduction of area in iron is a requirement which ought not, I think, to be very minutely interpreted, on account of the difficulty of measuring it accurately, due to the incipient opening-up of the welds at the point of fracture. In steel the reduction of area is often the best indicator of the ductility of the specimen, and taken together with the character of fracture, which should always be noted, it is an important factor in the estimation of quality in this respect. The specified percentage of reduction of area is almost always obtained in the best practice, in iron as well as steel, and the difficulty with iron is not that the substantial requirement has not been reached, or even exceeded, but that the exact measurement is not easy; and if it is reported with professed accuracy for the satisfaction of the engineer, he must not infer too much from the figures.

No general rule can be stated for the demand as to the character of fracture under tensile tests, but it may be safely said that for iron and for steel of 70,000 lbs., tensile strength the fracture should show the flow of the metal—fibrous, not crystalline—to at least 80 per cent. in the case of wrought iron, and that in steel it should be silky rather than spongy and granular.

In the interpretation of tensile tests of steel, the hardness of the metal is an important element. It has been found by experience that bridge steel of over 64,000 lbs. tensile strength is so hard that in punching it minute fractures will be made in the metal surrounding the holes, which will be so injured by the operation that tensile specimens taken from punched pieces show very considerable decrease in tensile strength.

The usual instruction given by engineers to inspectors is that steel which is above 62,000 or 63,000 lbs. per square inch tensile strength should be held quite rigidly to the results of the tests in acceptance or rejection; but where the steel is milder, a test varying 1,000 or 2,000 lbs. over or under the requirements of the specifications is not generally considered, by itself, a cause for rejection. In this connection it is well to point out that duplicate results taken upon the same lot of homogeneous test-specimens, as shown in the tabular reports of the committee of the American Society of Mechanical Engineers, exhibit a variation much greater than this limit, which is usually allowed in the acceptance of material. There are some engineers, however, who are very rigid in their requirements that all the material shall answer precisely all the tensile requirements. In such cases either the requirements should be very broad and lenient or the metal should be paid for at a considerably increased price per pound.

With wrought iron the general practice of engineers is to allow their inspectors a considerably larger variation in acceptance of tensile results than with steel. This practice, I think, is warranted. Wrought iron made in different districts of the country, from varying stocks, gives varying results. In eastern Pennsylvania, where the furnaces have largely run in the past on foreign ores, the bar-iron is somewhat lower in tensile strength, but is greater in elongation and reduction of area than that made in the western part of the state, from Lake Superior ores. In the eastern district it is easy to obtain the best bar-iron with 48,000 lbs. per square inch tensile strength and 20 per cent. elongation in 8 ins., while in the western part of the state 50,000 to 51,000 lbs. per square inch tensile strength is exhibited with 16 to 18 per cent. elongation in 8 ins. In either case the engineer can, in my judgment, safely trust the bar-iron with the same unit strains.

With a specification for wrought iron similar to that outlined in our paper upon "The Inspection of Materials of Construction in the United States" (Trans. Am. Inst. M. E., XIX., 911), I believe a reasonable allowance of a few thousand pounds per square inch, or a few units per cent. in ductility, according to the character of the metal being made at the mill, should be permitted to the discretion of the inspector, or, preferably, the specifications should be broad enough to admit both varieties of metal.

The requirement of 52,000 lbs. per square inch tensile strength for bar iron for structural purposes cannot, according to my experience, be met without many rejections by mills in general. Very few mills in this country, except those working charcoal iron or using steel scrap in the piles, could produce regularly such bar-iron. An iron having this high tensile strength should be carefully tested for welding, as it is very apt to be dry and incapable of welding strongly, and if it satisfactorily answers both requirements, it should command a higher price than ordinary good bar-iron.

Since the price of soft steel (of not too rigid requirements) and that of wrought iron are now about the same, it is becoming a common practice to allow in specifications for structures the use of either wrought iron or steel, giving specifications for both. This practice has led, both at the bridge shops and at the mills, to the interpretation that the material may be furnished in both iron and soft steel up to 56,000 to 64,000 lbs. tensile strength, as it pleases their convenience. The writer has had several experiences of late where the mill people, under such specifications, have actually attempted to fill the items of angles and plates partly in iron and partly in steel. This indiscriminate use of iron and steel, with their different moduli of elasticity and expansion and contraction under varying temperatures, does not seem to be good engineering practice. Of course this remark does not apply to all cases, but only to those in which the differing behavior of the two materials may produce injurious strains.

VI. What Material the Tests Should Cover.—As before explained, the series of tests with open-hearth or Bessemer steel usually cover each melt, and with iron each lot of varying section; but where some of the tests prove defective, they may fairly be construed to cover smaller subdivisions under certain conditions. If it can be shown that the cause of the trouble is with only one reheating furnace-charge, or even with certain ingots or blooms near bridge walls or exposed to special punishment, it is manifestly fair to all interests to reject only the material that can be proved to be defective, taking further tests of the remainder of the lot.

VII. The Jurisdiction of the Inspector over Rejected Material.—In one view of the subject the inspector, who does not own any of the material (although the mill people claim that inspectors sometimes act as if they did, with the addition of the mill and all the property and people pertaining thereto), has nothing further to do with material that he rejects. Certainly he has no right, without the mill manager's consent, to maltreat rejected bars so as to prevent their being used for some other purpose. At the same time it seems to me that he has the right to mark rejected material in such a way that it may not, by any accident or otherwise, be shipped forward from the mills with the accepted material. For this purpose many inspectors have a private stamp for stamping rejected material, which seems to be a wise precaution.

VIII. The Jurisdiction of the Inspector over Accepted Material.—The inspector should be furnished with lists of the material he has inspected or shipped on each car load, in order that he or his assistant, the inspector at the shop, may identify the material which he has passed as it is unloaded at its destination. For this purpose many engineers—it seems to me very properly

—insist that their inspectors shall approve the itemized bills of lading of each car load of accepted material from the mills.

The inspector should, where possible, see that material is properly loaded on cars for shipment, in order to prevent its being badly bent and twisted in loading or in transit. This is a matter of no little importance with the large bars of 90 and 70 ft. now often ordered at the mills.

IX. The Right and Duty of Inspectors to Note and Report upon Methods of Manufacture.—Many mill people claim that if the inspector is furnished with material answering the requirements of the specifications, there their duty ends, and any investigation into the methods of manufacture is unwarranted and unnecessary and is prohibited. On the other hand the manufacturers are constantly pressing for fewer tests upon the tonnage they turn out, and in the judgment of the writer the best way to reduce the number of such tests is to make the inspector familiar with the methods by which his material is made, and thus able to judge more accurately of the uniform character of the stock used, the size of the ingots or piles or blooms from which finished material is rolled, and the manner in which the material is rolled or hammered. Without this knowledge, and actual testing of the materials used, steel scrap ought not to be allowed to be piled with iron.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

FINDLAY, FT. WAYNE & WESTERN.—The engineers of this company have completed the surveys for the proposed extension from Findlay, O., east to Greenwich, O., 60 miles. It is stated that the right of way is being secured and that the line will be completed this season.

BROWNSTONE & MIDDLETOWN.—This 2½-mile railway from Brownstone to Waltonville, Pa., has been completed and put in operation.

FALL BROOK COAL CO.—Local papers state that this company is considering the construction of a line from Corning to Penn Yan, N. Y., over the abandoned roadbed of the Corning & Sodus Bay R. R.

COOPERSTOWN & CHARLOTTE VALLEY.—At a meeting of the Directors, recently held, it was decided to complete the partly graded extension from West Davenport to Davenport Center, N. Y., 3 miles, at once.

PITTSBURG & LAKE ERIE.—This company has secured a charter to build the proposed link between its line and the Beaver & Ellwood R. R., near Rock Point, Pa.

BALTIMORE & LEHIGH.—The surveys have been completed for the proposed line from Chickies to Red Lion, Pa., and a very satisfactory route has been secured. The maximum grade is 50 ft. per mile. There is a prospect that the line will be built soon.

FINDLAY BELT.—Work will be resumed upon this 7-mile belt railway at Findlay, O., about May 1.

CLEVELAND, WOOSTER & MUSKINGUM VALLEY.—The surveys have been completed for the extension of this road from Wooster, O., south to Millersburg, O., 20 miles, and grading is now in progress. The contractors are Ryan & McDonald, of Baltimore, Md., who built 20 miles of the same line from Lodi to Wooster, O., in 1891. The proposed extension is to be completed this year.

BALTIMORE & OHIO.—The engineers of this company are making the preliminary surveys for the proposed line from Pennsgrove, N. J., to Cape May, N. J., 80 miles.

EAGLE'S MERE.—Work has been begun upon this 6-mile line from Sonestown, Pa., on the Williamsport & North Branch R. it, to Eagle's Mere, Pa. All of the rolling stock for the new line has been purchased, and it is expected to have the line in operation by July 1, 1892.

CHICAGO, EVANSVILLE & CHATTANOOGA.—The engineers are now making surveys and securing the right of way for this line from Chattanooga, Tenn., to Bowling Green, Ky., 155 miles. The line from Bowling Green, Ky., to Evansville, Ind., has been located and is under contract. Ch. Engr., A. B. Fitch, Terre Haute, Ind.

SANDUSKY & COLUMBUS SHORT LINE.—All the subcontracts have been let for the extension from Bellevue, O., south, and work is in progress all along the line. Ch. Engr., F. J. Aid. Columbus, O.

PENNSYLVANIA.—Work has begun double tracking the Trenton cut-off from Glen Loch, Pa., to the Schuylkill River at Morristown, Pa.—It is stated that the Philadelphia & Delaware County R. R. will be extended from Angoria, Pa., to Newton Square, Pa., about 9 miles.

Projects and Surveys.

HAGERSTOWN & STATE LINE.—A press dispatch says: "A bill incorporating the Hagerstown & State Line R. R. Co., which passed the legislature, without attracting any attention, now turns out to be an important part of the alliance between the Baltimore & Ohio, the Philadelphia & Reading, and the Western Maryland. From official sources it was learned to-day that the agreement between the companies contains a covenant upon the part of the Western Maryland to construct a cut-off road between a point near Hagerstown Station to Five Forks, a few miles northwest from Waynesboro, in Franklin Co., Pa."

UTICA & UNADILLA VALLEY.—Meetings are now being held at the various towns along the route of this proposed railway from Bridgewater, N. Y., to New Berlin, N. Y., 20 miles, to raise the money necessary to secure the right of way. The local papers state that the sum required, about $32,000, will probably be raised.

GOUVERNEUR & OSWEGATCHIE.—Chartered in New York to build a railway from Gouverneur, N. Y., on the Rome, Watertown & Ogdensburg R. R., east to Edwards, N. Y., about 13 miles. The incorporators are mostly officials of the New York Central & Hudson River R. R. Co.

PHILADELPHIA & NORTHERN.—Chartered in Pennsylvania to build a railway from a point at the intersection of Western and Duncannon Sts., in Philadelphia, Pa., to Glenside, Pa.; Pres., E. Lawrence Fell, Philadelphia, Pa.

LAKE HOPATCONG.—At a recent meeting of the promoters of this railway the following officers were elected: Pres., Chas. E. Noble, Morristown, N. J.; Secy., J. Ward Smith, Newark, N. J.; Treas., Theodore King, Ledgewood, N. J., and Gen. Supt., Wm. E. King, Hopatcong Landing.

DELAWARE & NORTH RIVER.—There is some possibility that this old enterprise may be carried to completion. A majority of the stock and bond holders of the Port Jervis, Monticello & New York R. R. have consented to the consolidation of that company with the Delaware & North River R. R., and have also agreed to make contracts with J. E. Bloom, Temple Court, New York City, to construct the unfinished line. It is stated that as soon as a few more stockholders shall assent to the consolidation work will be commenced.

WHEELING & BELMONT.—Chartered in Ohio to build a railway from Wheeling, W. Va., to Belmont, O.

PHILADELPHIA & WEST CHESTER.—Chartered in Pennsylvania to build a railway from West Chester, Pa., to Eaton Station, on the Chester Valley R. R. Pres, Geo. A. Aldrich, 1645 South Broad St., Philadelphia, Pa. Press dispatches state that surveys are now in progress and that the line will be completed by Sept. 1.

Southern.—Existing Roads.

LOUISVILLE & NASHVILLE.—The contract for building the Clarksville Mineral branch from Marion to Van Leer, Tenn., 7 miles, has been let to Cohan Bertham, of Clarksville, Tenn. Work is to begin at once.

LOUISVILLE, ST. LOUIS & TEXAS.—This company has surveyed a line to West Point, Ky., 22 miles long. The object of the branch is to secure an independent line into Louisville, Ky.

GURLEY & PAINT ROCK VALLEY.—The contract for constructing 30 miles of this railway from Winchester, Tenn., to Deposit, Ala., 65 miles, has been let to Allen, Moseley & Co., Rocky Mount, Va. The portion of the line under contract runs from Gurley, Ala., north to the foot of Cumberland Mountain, and it is to be completed by Dec. 1.

OWENSBORO, FALLS OF ROUGH & GREEN RIVER.—Surveys will soon begin for an extension from Reynolds, Ky., to a connection with the Newport News & Mississippi Valley R. R. at Horse Branch. It is expected to begin construction by May 1 and to have the line completed by Dec. 1.

NORFOLK & WESTERN.—Surveys will soon begin for the branch from the main line of the Ohio extension to coal mines in Logan Co., W. Va.

ALABAMA GRAND TRUNK.—Ten miles of this line from Montgomery, Ala., toward the Tallapoosa River have been graded and tracklaying will be begun soon. Only four miles more remain to be built to take the line to the river.

Projects and Surveys.

GLADE CREEK & PINEY RIVER.—Chartered in West Virginia to build a railway from Glade Creek to Piney River, Raleigh Co., W. Va. Among the incorporators is Jas. W. McCreery, Raleigh, C. H., W. Va. The principal officers will be at Coal Gate, W. Va.

WINSTON & BONE VALLEY.—The officers of this company whose incorporation was noted in our issue of April 9, are: Pres., J. E. Griffin; Secy., Simeon Griffin; and directors John Beattey, John G. Scruggs and Mitchell Brice. The road is projected to run from Winston, Fla., to the mouth of the Manatee River, about 60 miles, and 11 miles have already been graded.

HINTON & NEW RIVER.—At a meeting of the directors recently held it was decided to proceed with the surveys of this railway from Hinton, W. Va., to the mouth of East River, 30 miles, at once, with the view of asking bids for construction by July 1, if possible. Ch. Engr., E. S. Hackett, Colt, W. Va.

ATLANTIC & ALABAMA.—Sec., L. E. O'Keefe, Atlanta, Ga., writes us that this company is now negotiating with English capitalists for the sale of its bonds. The road is projected to run from Atlanta, Ga., to Selma, Ala., 204 miles, and the line has been located and most of the right of way secured. Pres., Henry B. Tompkins.

BEAVER CREEK.—B. Gilpen Smith, of Conowingo, Md., writes us that the surveys have been begun for this line from Davis, W. Va., up Beaver Creek and down the Stoney River to about 2 miles below Gorman on the West Virginia Central & Pittsburg R. R., a distance of 25 miles. Thos. Dailey, of Davis, W. Va., Ch. Engr.

BEDFORD & JAMES RIVER.—R. Kenna Campbell, Bedford City, W. Va., writes us that the preliminary surveys have been completed from Bedford City, W. Va., to Big Island, on the James River, 22 miles, and that the route south of Bedford City will pass through Rocky Mount and Stuart to the North Carolina line. The line will pass through an undulating country rich in timber and minerals. Pres., W. W. Berry; Ch. Engr., S. B. Mosby.

Northwest.—Existing Roads.

CHICAGO & EASTERN ILLINOIS.—The contract for building the second track from Momence to Danville, Ill., 50 miles, has been let to W. P. Chapman, Elgin, Ill.

IOWA CENTRAL.—Surveys have been begun for a line from Fremont to Ottumwa, Ia. It is the intention of the company to build the line this season.

DULUTH & IRON RANGE.—Bids have been received and contracts will soon be let for building the branch to Messabi Iron Range. The country is very rough and the work will be heavy. There will be three cuts of 20,000, 16,000 and 12,000 cu. yds., respectively.

CHICAGO, MILWAUKEE & ST. PAUL.—This company will, it is stated, complete at once the Whetstone branch into the Sisseton Indian Reservation.

WABASH, CHESTER & WESTERN.—The contract for building this road from Tamaroa to Mt. Vernon, Ill., 22 miles, has been let to N. W. Irish & Co., of Carlyle, Ill. Ch. Engr., Robert Moore, St. Louis, Mo.

Southwest.—Existing Roads.

TEXAS, LOUISIANA & EASTERN.—It is stated that Chas. M. Putnam, of Boston, Mass., has a contract for building the first section of 80 miles of this road from Conroe, Tex., east toward Alexandria, La.

TEXAS PACIFIC.—A press dispatch from El Paso, Tex., says: "Reliable information from railway officials is to the effect that the Texas & Pacific Ry. Co. has changed its intentions of building into this city from Sierra Blanca, but instead will tear up the track from Pecos to Sierra Blanca and utilize the Pecos Valley Ry. to Eddy, N. Mex., and from there a track will be laid to Roswell and thence extended on to El Paso. A 40-mile spur will be built to the coal fields at White Oaks from Roswell. This new route will bring the Texas & Pacific Ry. through the fertile valley and rich mineral country north of the old route, which is through a barren country and very slightly inhabited. Mr. Jay Gould is maturing these plans and will shortly make a transfer of the Pecos Valley Ry. to the Texas & Pacific. He already owns the first mortgage bonds of the former road. The change in the line will bring the road through the Texas Pacific land, and it is said these lands will be mortgaged to extend the road through Mexico to the Pacific Coast."

CHICAGO, BURLINGTON & QUINCY.—The contractors, Quigley & Co., of St. Louis, Mo., are making good progress on the cut-off to Bellefontaine Bluffs, Mo., 30 miles.

Projects and Surveys.

BENTONVILLE & SULPHUR SPRINGS.—Chartered in Arkansas to build a railway from Bentonville to Sulphur Springs, Ark., about 25 miles. Among the incorporators are R. B. Schneider, Tremont, Neb.; A. J. Bates, Bentonville, Ark., and Chas. H. Habler, Sulphur Springs, Ark.

GEORGE CREEK & HARRISON.—The citizens of Boone Co., Ark., have completed negotiations with W. E. Winner, by which they agree to give him $37,500 in cash, and also 500 acres of land per mile of road, on condition that he construct a railway from George's Creek to Harrison, Ark., 25 miles.

NEW ORLEANS BELT.—It is stated that Adolph Schreiber and others have applied to the New Orleans City Councils for a franchise to build a belt railway around the city.

Rocky Mt. and Pacific.—Existing Roads.

GREAT NORTHERN.—A gap of only about 70 miles remains unfinished in the line from Kalispell, Mont., to Spokane, Wash. Tracklaying is in progress at both ends of this gap and it will probably be completed in a few weeks.

ASTORIA & PORTLAND.—The contract for grading 85 miles of this road has been let to Corry Bros. & Co. Work will begin soon.

NORTHERN PACIFIC.—The extension to South Bend will be completed between July 15 and August 1 of this year. A large force of men are at work on the fifth and last bridge across the Chehalis River, near Pe Ell. The bridge consists of two spans of 150 ft. Between five and ten miles of road have been graded west of Pe Ell, and just as soon as the bridge is completed tracklaying will be pushed. Twenty-three miles of track have been ballasted from Chehalis. At Ward's Station, the first station from Chehalis, the depot and other buildings have been completed and a number of similar buildings are in course of erection at Pe Ell. An iron bridge of the Howe truss pattern will be placed across the south fork of the Willapa River. This will be the only iron bridge on the line. The material for the bridge is being shipped from Portland. Contracts have been awarded to Mr. Gray, of South Bend, for supplying lumber for the bridge at that end.

DENVER, APEX & WESTERN.—It is stated that the contract for building this line west from Denver, Colo., will be let in a few days.

MISSOURI PACIFIC.—A press dispatch from Pueblo, Colo., says: "A surveying party, believed to be in the employ of the Missouri Pacific Ry. started out from this city this morning. It is thought here that the party is to make a final survey along the line of the proposed Pueblo, Gunnison & Pacific Ry. An evening paper states that Messrs. Carlisle, railroad contractors, who build the Colorado line for the Missouri Pacific, have been in conference with Mr. Jay Gould in El Paso. Extra men have been at work in the office of H. R. Holbrook, Chief Engineer for the Missouri Pacific Colorado line, in preparing tracings for the preliminary survey of a line west from Pueblo. No one in possession of information here will either admit or deny these rumors."

SOUTHERN PACIFIC.—Work has been begun on the line from Bakersfield, Cal., toward Armona, Cal., 48 miles, with a force of 300 men and 200 teams. The line will be laid with 50-lb. steel rails, and there will be 2,600 ties to the mile.

COLORADO MIDLAND.—It is stated that construction will soon begin on the branch to Cripple Creek, Colo.

Projects and Surveys.

SAN FRANCISCO & SALT LAKE.—The San Francisco "Chronicle" says that a number of the wealthiest men of that city have been meeting together for the past six months considering plans and subscribing money to commence the construction of a railway to compete with the Central Pacific. They have pledged themselves to build a road between that city and Salt Lake. Each of them have agreed to put up the sum of $100,000, and each has already paid into a local bank the sum of $25,000 in cash. The men engaged in this enterprise are Alvin Z. Hayward, W. L. Hobart, James G. Fair, James Phelan, A. L. Hollidie, W. W. Montague, Adam Grant, Joseph Donohue, J. B. Stetson, and many others. In the agreement signed by these men they pledge themselves to build the road, and agreed not to sell the road or to enter into any traffic agreement with any competing line for a period of at least ten years from the time the road is completed. Engineers are in the field, and the preliminary surveys have been submitted to the Executive Committee. Three million dollars have been subscribed, and the balance of the money required will be raised by floating bonds and selling stock of the company.

SANTA FE & MONICA.—Chartered in California to build a railway from Mesmer, Cal., to Santa Monica, 5 miles. Among the incorporators are F. B. Henderson, F. H. Pattee and L. Mesmer all of Los Angeles, Cal., where the principal offices will be located.

STOCKTON & BAKERSFIELD.—Chas. Ertz, of San Francisco, Cal., Pres., is reported as saying that surveys will begin at once for this proposed line from Stockton to Bakersfield, Cal. Virgil & Bogue, are the engineers.

SAN JOSE & SAN FRANCISCO TRANSPORTATION CO.—Chartered in California to build a railway from San Jose to Alviso. Among the incorporators are Jos. H. Rucker, M. Phillips and Jas. Deitrich, of San Jose, Cal.

NELSON & FT. SHEPPARD.—This company, which proposes to build a line of railway connecting the Kootenai mining district with the Spokane Falls & Northern R. R., is applying to the Dominion Government for a charter.

Foreign.

MEXICO, CUERNAVACA & PACIFIC.—Grading has been finished to Castaneda, and is being rapidly pushed forward. One hundred tons of rail have arrived at Vera Cruz, 1,000 tons are on the way to Tampico, and 4,000 tons more have been ordered. This amount is sufficient to complete the line to Contreras.

HONDURAS.—It is announced that the English syndicate holding the concession for the building of the Inter-Oceanic Railway across Honduras from Puerto Cortez to Amapala petitioned for an extension of time, their contract having lapsed March 12, and that the Government refuses to grant it. The syndicate has been notified of the revocation of the contract. The Government has, however, made a definite concession for the same purpose to American parties, headed by W. S. Valentine and R. H. Van Auken, Jr., of New York city, to whom is ceded the local railroad now existing, an immense amount of land, and other valuable grants.

ELECTRIC RAILWAYS.

NEW UTRECHT, N. Y.—The Coney Island, Fort Hamilton & Brooklyn Ry. Co. has applied for permission to build an electric railway.

SIOUX CITY, IA.—Surveys are being made for the Sioux City & Leeds electric line.

LEAVENWORTH, KAN.—The Rapid Transit Ry., now operated by steam motors, is to be converted into an electric line.

DENVER, COLO.—The Denver, Lakewood & Golden Ry. will build an electric branch to Garfield Heights and Fort Logan, a distance of 5 miles.

SAN JOSE, CAL.—The San Jose & San Francisco Transportation Co. has been organized by J. M. Rucker and James Dietrick, of San Jose, to build an electric road to Alviso. Capital stock, $500,000.

WACO, TEX.—The Waco Electric Street Railway & Electric Light Co. has acquired the property and franchises of the Waco Dummy Ry. Co.

NIAGARA FALLS, ONT.—The Niagara River Ry. Co. will commence work at once on the line to Queenston, Ont. The work has been let in five sections.

HORSE RAILWAYS.

BRIDGETON, N. J.—The Bridgeton Street Ry. Co. has been organized to build five miles of road. Pres., Dr. H. K. Trask; Secy., A. R. Fithian.

CATASAUQUA, PA.—The Catasauqua & Northern Street Ry. Co. has been organized to build a line to Coplay. Capital stock, $50,000. Pres., G. H. Campbell.

LAWRENCEVILLE, PA.—Lawrenceville & Schenley Park Street Ry. Co.; $100,000. Pres., Charles Hood, Pittsburgh.

WILLIAMSPORT, PA.—Junction Passenger Railway Co.; $60,000; commencing business with $6,000. Pres., Hugh McDowell.

CLEVELAND, O.—T. B. Townsend & Co., of Zanesville, have the contract for the belt line, 7½ miles long.

INDIANAPOLIS, IND.—The Indianapolis Street Ry. Co., capital stock, $1,500,000, has been incorporated by E. F. Leonard, J. U. Bunn and A. L. Mason.

MILWAUKEE, WIS.—The Milwaukee Street Ry. Co. will extend its line 1½ miles along the Howell road.

HIGHWAYS.

NEW YORK.—Work has been commenced on the macadamizing of the Flushing and Jamaica highway. The work is in the hands of Contractors Skeuse and Andrews. The improvements will cost in the neighborhood of $40,000. The expense is to be divided between the towns of Flushing and Jamaica, the former paying three-fifths and the latter two-fifths.

PENNSYLVANIA.—Cheltenham township, Montgomery Co., proposes to issue bonds to the amount of $80,000 for the purpose of macadamizing 12 miles of road.

OHIO.—Proposals will be received until May 9 by H. J. Caren, Auditor of Franklin Co., at Columbus, O., for the improvement of Fifth Ave. from the Olentangy River to the Scioto River, a distance of 11,747 ft. The roadway is to be opened and graded 60 ft. in width; two sidewalks, each 12 ft., one roadway 36 ft., macadamized, and is to have one line of 4-in. curb on each side of the roadway. The quantities are as follows: 82,818 cu. yds. of excavation; 21,900 ft. of straight curb, 4 ins.; 775 ft. of circle curb; 10,196 cu. yds broken stone; 444 rods of 8-in. tile; 280 rods of 7-in.; 122 rods of 6-in.; 122 rods of 5-in.; 122 rods of 4-in.; 8 sewer drops; 800 ft. of 18-in. pipe; 8,075 sq. yds. of block gutter.

BRIDGES, TUNNELS AND CANALS.

ROCHESTER, N. Y.—A bill is to be introduced in the New York Legislature to authorize the city of Rochester, N. Y., to issue bonds to provide for the construction of three bridges across the Genessee River at Court, Andrews and Clarissa streets.

GRAND RAPIDS, MICH.—The Aldermen's committee have reported favorably for the construction of a viaduct over the railway tracks on Williams St. The structure will cost about $50,000.

WILLIAMSTON, MICH.—A bridge to cost $5,000 will be built over the Cedar River at Putnam St.

ST. CHARLES, MO.—It is announced that a highway bridge will probably be built over the Missouri River at this point. The structure will cost about $250,000. It is stated that the money will be supplied by a Japanese syndicate.

ST. LOUIS, MO.—It is reported that the Gould railways will build another bridge over the Mississippi River at this point, under the charter of the East Carondelet & St. Louis Bridge Co., granted some years ago.

WATER-WORKS.

New England.

CAPE ELIZABETH, ME.—The people have voted for works. The Standish Water & Construction Co. wish to supply water in the town to the villages of South Portland, Willard, Knightsville, Town House, Corner, Turner's Island, Pleasantdale, Ligonia, and Cash's Corner. It proposes to lay not less than 34,000 ft. of 8-in., 20,000 ft. of 6-in., and 12,000 ft. of smaller pipe, and 50 hydrants will be set. The supply will be from the mains of the Portland Water Co., and a 600,000-gallon stand-pipe will be built. It appears that the people voted in favor of a franchise with the above terms.

MEREDITH, N. H.—Private works are projected at an estimated cost of $20,000.

BROOKLINE, MASS.—The sum of $30,000 has been voted for a new high duty pumping engine and two boilers for the low service pumping station; $30,000 for a covered reservoir; and $20,000 for the enlargement of the low service pumping station.

IPSWICH, MASS.—Works are projected.

LYNN, MASS.—There is talk of a new storage reservoir at an estimated cost of $150,000.

MALDEN, MASS.—The Council has ordered the issuance of $20,000 of bonds for construction.

ORANGE, MASS.—John W. Wheeler, C. C. Fowler and others are on an advisory committee in connection with the town works, for which $125,000 was recently voted.

WARREN, MASS.—The sum of $600 has been voted to pay the expenses of a water-works investigating committee, consisting of Chas. D. Keys, C. O. Walker and others. There are now some small private pipe lines and a small town fire protection plant.

NEWINGTON, CONN.—Subscriptions to an increase of the company's stock are being received, it being proposed to lay a larger supply main. Pres., Erastus Kilbourne.

Middle.

ALBANY, N. Y.—The Governor has signed the $500,000 water supply bill.

BURKE, N. Y.—The company has bought additional land containing springs and will build a reservoir. C. M. Jameson, Secy. and Treas.

FAYETTEVILLE, N. Y.—Wm. Austin, Dr. T. E. Quinby and others have been appointed to investigate works.

NEWBURG, N. Y.—A pumping station for temporary use is projected.

RIVERHEAD, N. Y.—J. Henry Perkins, John R. Perkins and T. M. Griffin have a franchise for works. The supply to be pumped from a spring to a 90-ft. stand-pipe, it is said.

ROCHESTER, N. Y.—A bill has passed the Legislature authorizing the issuance of $1,750,000 of bonds for a new water supply.

SYRACUSE, N. Y.—Engr. W. R. Hill has been authorized to ask bids for a 30-in. iron supply main from the lake. Bids will probably be asked soon for $500,000 of water bonds.

OCEAN CITY, N. J.—The Ocean City Water-Works Co. has been incorporated by C. J. Young, Philadelphia; H. B. Adams, Ocean City, and others; capital stock, $50,000.

GREENSBURG, PA.—H. F. Labelle will superintend improvements here.

HALLSTEAD, PA.—It is reported that the Hallstead Water Co. has been incorporated with W. F. Hallstead, Geo. B. Jermyn and others as directors; capital stock, $25,000.

JEANETTE, PA.—The Westmoreland Water Co. has offered to furnish hydrants at $50 each per annum. A committee will be appointed to consider the matter.

LANCASTER, PA.—Council's Special Reservoir Committee has directed the Mayor to issue $150,000 bonds for a new reservoir. C. G. Bassler is Clerk of the committee.

PHILADELPHIA, PA.—Councils' Water Committee is considering an ordinance authorizing a $150,000 filtering plant at the Belmont station, and also a plant at Lardner's Point, on the Delaware.

Southern.

TARBORO, N. C.—Henry Hungerford, Baltimore, has made an offer for a franchise, including the purchase of the present small plant, which seems likely to be accepted.

ATHENS, GA.—The Commissioners will soon report on new works and have agreed to employ R. Hering as Engineer. Secy., C. M. Strahan.

DARIEN, GA.—The people have voted, 52 to 49, for works.

FORT VALLEY, GA.—It is reported that the town is bonded for $25,000 for the purpose of building works.

LA GRANGE, GA.—The people have voted for water and electric lighting plants.

TITUSVILLE, FLA.—The "Advocate" urges that estimates for works be secured, or a water company organized. It favors a well 20 ft. in diameter, with pumping to a stand-pipe.

BREWTON, ALA.—The contract for water and electric lighting plants has been awarded John H. Turner & Co., Mobile, for $19,981. There will be an artesian well, four miles of mains and 25 hydrants; also, 15 arc and 300 incandescent lights.

MOBILE, ALA.—Mayor J. C. Rich informs us that the Council has appropriated $2,500 for the employment of an engineer to report on sewerage and water-works. A man will be engaged prior to May 1. A. S. Lyons, Chn. Special Committee of Council.

North Central.

KENTON, O.—It is reported that the works are to be extended.

NAPOLEON, O.—May 3 the people will vote on the acceptance of the water and electric lighting enabling act.

WEST MILTON, O.—Authority has been secured to issue $15,000 of bonds for works.

WILLSHIRE, O.—It is reported that works will be built. Population, 600.

BREMEN, IND.—It is reported that Jas. Madden, a plumber of Fort Wayne, has a contract for works here; price, $15,000.

EDINBURG, IND.—Works are projected.

DANVILLE, IND.—Cliff & Co., Terre Haute, have the contract for the stand-pipe and boilers for the works here.

MICHIGAN CITY, IND.—Improvements are projected; estimated cost, $25,000.

STERLING AND ROCK FALLS, ILL.—The Sterling Public Works Co. has been incorporated to furnish water, gas, and to operate street railways in Sterling and Rock Falls. The Sterling Water Co. built works in 1886 to supply these towns.

WESTERN SPRINGS, ILL.—The contract for works has been awarded to MacRitchie & Nichol, Chicago, at $79,000. Ethan Philbrick, Chicago, Engr.

WAUKEGAN, ILL.—The North Shore Water Co., the incorporation of which was noted last week, proposes to supply water to towns along Lake Michigan, between Chicago and the northern boundary of Illinois.

KAUKAUNA, WIS.—Mr. J. A. Southers, representing Hyde & Jackson, New York, has presented plans in connection with an application for a franchise. The proposed works are estimated to cost $100,000.

NEENAH, WIS.—A special water-works election is proposed.

PRESTON, IA.—The "Advance" advocates action to secure works.

WEST LIBERTY, IA.—The people have voted $45,000 for works. A tank will be used.

KENYON, MINN.—Bonding for works has been postponed for consideration, May 1.

LANDER, WYO.—A 20-years' franchise has been granted to the Rocky Mountain Water Supply Co.

BUTTE, MONT.—We are informed that the company some time ago granted a franchise for works has bought the material for their construction; also that the works will include an 85-ft. dam, impounding 400,000,000 gallons. Chester B. Davis, Chicago, Engr. On the other hand the city is now advertising for bids for a new franchise, claiming that the above-named franchise is void through non-compliance. The company claiming the franchise, however, bought out an existing company and so has a foot-hold in Butte, and some valuable water rights.

Southwestern.

SEDALIA, MO.—The contract for the large new reservoir has been awarded to M. L. Andrews, St. Louis.

ROCKVALE, TEX.—George Shields, Pueblo, has the contract for works here, price, $21,300.

ROSEVILLE, TEX.—Works are projected.

Pacific.

PALOUSE, WASH.—Cy. Engr. Lewis is preparing estimates for the extension of the works.

PORT ANGELES, WASH.—The Angeles Water Co. has been incorporated; capital stock, $150,000. The Port Angeles Gas & Water Co. built works in 1891.

SPOKANE FALLS, WASH.—Bids for pumps are wanted. Cy. Engr., Oskar Huber. It is reported that Cutter & Post are making plans for the new "up river" works.

SANTA ROSA, CAL.—G. A. Tupper and F. Berka, special water committee, have reported on city works, including 14 to 6-in pipe, 100 hydrants and a pumping plant; estimated cost, $150,000. A company now supplies the city.

KENDRICK, IDAHO.—A citizens' meeting has been held to discuss works and a committee has been appointed to report on the subject.

Canada.

MONTREAL, P. Q.—Bids are wanted until April 12 for 40 tons of soft pig lead. Supt., B. D. McConnell.

IRRIGATION.

CHEYENNE, WYO.—The "Leader" states that Wm. Sturgis is interested in a proposed company and the building of a projected dam near Sherman, Wyo. The dam will be a rock fill structure, 60 ft. high. In the Cheyenne Canyon of Crow Creek a second storage reservoir is projected.

PUEBLO, WYO.—The Pueblo Canal Co. has just been incorporated with a capital stock of $1,250,000. It proposes to put in a head gate near Canyon City and build a canal 70 miles long, 40 ft. wide on the bottom and 8 ft. deep; capacity, 1,536 cu. ins. per sec. Pres., A. R. Pierce; Ch. Engr., W. P. Hobson.

NEW COMPANIES.—Snake River Canal Co., Basalt, Idaho; $50,000. Snake River Valley & Reservation Co., Idaho Falls, Idaho; $100,000. Woodville Canyon Co., Idaho Falls, Idaho; $15,000.

SEWERS.

MANCHESTER, N. H.—The "Press" says the city needs an immediate loan of $250,000 for streets and sewers.

ROCHESTER, N. H.—The Council has voted an appropriation for plans for a complete system.

BOSTON, MASS.—The Metropolitan Sewerage Commissioners ask bids until May 7 for section 27 in Somerville and Cambridge. See advertisement. The Senate Committee on Expenditures has reported an act to provide for the Charles River Valley system of sewerage. For this system of sewage disposal for Boston, Newton, Waltham, Watertown and Brookline, it is proposed to appropriate annually for four years from $26,500 to $28,000.

BROOKLINE, MASS.—In addition to the usual appropriation of $25,000 for sewers, the Council has voted $16,500 for a sewer in Beacon street.

MALDEN, MASS.—The City Engineer has prepared plans for a system of sewerage in connection with the Metropolitan system of Boston, a main line of which will run through this city to Melrose. The main pipes will be from 6 to 36 ins. diameter, and the Council has voted to issue bonds for $70,000 to construct the same.

REVERE, MASS.—The sewer contract has been awarded to the National Construction Co., at $49,000, the work to be completed by Nov. 1.

NEW HAVEN, CONN.—At the meeting of the Council April 13, the City Engineer was directed to ask bids for two sewers, the bids to be opened in two weeks.

NEW LONDON, CONN.—The Sewer Board will soon construct a new outfall sewer. A masonry chamber, 6 ft. by 11 ft. and 8 ft. deep, will be built, and the outfall proper will be a 24-in. wooden pipe extending out 900 ft. under the harbor. The staves will be 3 ins. thick and bound together with ¾-in. galvanized steel hoops, covered with asphalt. The whole will be kept in place with weights of old rails.

CLINTON, N. Y.—The State Board of Health has approved the plans prepared by A. M. Scripture, of New Hartford. Vitrified pipe from 6 to 20 ins. in size will be used, and the estimated cost is $20,000.

ILION, N. Y.—A Board of Sewer Commissioners, including C. E. Pettie and G. F. Wilcox, has been appointed, and petitions have been signed by the citizens asking that the necessary steps be taken for putting in a system.

JAMESTOWN, N. Y.—The Council has contracted with O. N. Gardner to make surveys and estimates for a system.

NEW YORK, N. Y.—Bids are asked until April 26 for two sewers. L. J. Heintz, Comr. St. Impts., Wards 23 and 24.

NIAGARA FALLS, N. Y.—The contract for three sections has been awarded to John Marsden, of Utica, at $19,008. Bids are now asked for 16 sewers in district No. 2.

ONEIDA, N. Y.—The plans for the proposed system have been approved by the State Board of Health. The plans call for three trunk sewers and disposal works,

KEARNY, N. J.—A contract has been awarded to Wm. Hanna & Co. The Council has voted in favor of sewers in three streets.

PERTH AMBOY, N. J.—Plans for a system to cost $15,000 are being prepared by C. C. Hornmann, Cy. Engr.

NANTICOKE, PA.—Plans for a complete system are being prepared. Bids will soon be asked for the main sewer from Main St. to the river.

COLUMBUS, GA.—Bids are asked until April 26 for 475 ft. of 4-ft. sewer. L. G. Schuessler, Chn., Com. on Sts. and Sewers.

MOBILE, ALA.—The city will employ an engineer to prepare plans for a system of sewerage.

BRIDGEPORT, O.—The city will spend $12,000 for sewerage.

CLEVELAND, O.—Bids are asked until April 27 for sewers in five streets, and until May 11 for sewers in four streets. R. R. Herrick, Director of Pub. Wks.

SANDUSKY, O.—Bids are asked by the City Clerk until April 25 for a sewer in one street, including all laterals, etc.

YOUNGSTOWN, O.—Bids are asked until May 10 for a sewer in Ford Ave. H. W. Calvin, Clerk, Cy. Comrs.

HUNTINGTON, IND.—The city proposes to spend $60,000 in converting a small creek which flows through the city into a sewer.

INDIANAPOLIS, IND.—The City Engineer has been directed to prepare the necessary papers for a sewer to be built according to the plans of Mr. Hering.

OTTAWA, ILL.—The Council has voted to build a trunk sewer in Ward 4, to cost not less than $10,000.

JANESVILLE, WIS.—Plans and specifications for a system have been prepared by C. F. Loweth, of St. Paul.

WEST DULUTH, MINN.—The Village Engineer is preparing plans for a complete system of sewers which will conform with the Duluth system. It is expected that construction will begin about July 1.

OMAHA, NEB.—Bids are asked until May 6 for a sewer system, etc., at Fort Niobrara. Capt. C. F. Humphrey, Quartermaster, U. S. A.

CRESTON, IA.—Plans for a system have been prepared by I. S. Roseberry, Cy. Engr. The mains will be 18 and 20 ins. in size, and the outlet not less than 24 ins.

ST. LOUIS, MO.—The Sewer Commissioners have prepared estimates for work aggregating $193,000.

LITTLE ROCK, ARK.—The city has 13 miles of the separate system, yet three-fifths of the city is without sewerage. The Mayor recommends forming the city into one district and constructing a 4-ft. brick main with eght miles each of 8-in. and 10-in. laterals.

STREETS.

NEW YORK, N. Y.—Bids are asked until April 26 for broken trap rock stone and Tomkins Cove bluestone, also for grading three streets. L. J. Heintz, Comr. St. Impts., Wards 23 and 24.

ROCHESTER, N. Y.—The contract for paving Concord Ave. with asphalt has been awarded to the Warren-Scharf Asphalt Paving Co., at $14,025.

TROY, N. Y.—The Legislature has passed the bill giving the city $125,000 for street improvements.

PHILADELPHIA, PA.—The Mayor has signed the ordinance for the Park boulevard. The total length will be 4,480 ft., width 160 ft., and the estimated cost, including land, $5,721,800.

SUNBURY, PA.—Market St. will be paved with brick at an expense of $20,000.

ROANOKE, VA.—Bids are asked by the Board of Public Works, until May 6, for paving several streets.

LEXINGTON, KY.—The Street Committee has prepared estimates for $340,000 worth of brick paving.

DEFIANCE, O.—The City Engineer has completed specifications for brick paving to cost $38,810.

TOLEDO, O.—Bids are asked until May 9 for paving one street with Trinidad asphalt on cement foundation. C. H. Durian, Cy. Clk.

OTTAWA, ILL.—A contract has been awarded to the Rockford Construction Co., at $74,964.

TERRE HAUTE, IND.—Bids are asked until May 10 for paving in four streets. C. H. Goodwin, Cy. Clk.

SAN FRANCISCO, CAL.—The estimates of the Superintendent of Streets for the coming year aggregate $730,705.

SPOKANE FALLS, WASH.—The lowest bid for grading Hilliard St. was that of Patchen Bros., $22,220. At a previous opening of bids the lowest was $27,000, and all were rejected.

ELECTRICAL.

HINTON, W. VA.—The Electric Light & Power Co. is in the market for an alternating 30-light arc dynamo, a 500-light incandescent dynamo, lamps, station equipment, etc., also for a 70 or 80 HP. boiler and engine.

LA GRANGE, GA.—The city has voted to issue bonds for electric lights.

WAPAKONETA, O.—The city will erect a plant to cost $20,000.

ROCKVILLE, IND.—The Council has contracted with the Rockville Electric Light & Power Co., for street lighting, at $70 per year per light. Pres., J. J. Higgins, of Indianapolis. The Thomson-Houston system will be used.

OCONOMOWOC, WIS.—The City Clerk has been directed to ask bids for street lighting.

SEATTLE, WASH.—The city is investigating the subject of electric lighting.

QUEBEC, QUE.—Bids are asked until May 4 for electric street lighting. C. Baillairge, Cy. Engr.

CONTRACT PRICES.

WATER-WORKS SUPPLIES.—Troy, N. Y.—A contract has been awarded to J. M. Warren & Co. for 10 tons of pig lead at $4.35 per 100 lbs.; 10 coils of ½-in. and 200 of ¾-in. and 25 tons of 1-in. lead pipe, at $4.75 per 100 lbs.

Reading, Pa.—The contract for 2,700 tons of 10-in. and 5,000 tons of 6-in. cast iron pipe has been awarded to the Reading Foundry Co. at $24.64 per gross ton.

SEWER PIPE.—South Framingham, Mass.—The contract for additional sewer pipe has been awarded to H. C. Kingman at the following prices: 12-in. Akron pipe, 25 cts. per lin. ft.; 10-in., 19 cts.; 8-in., 13¼ cts.; 6-in., 9 cts.; 6-in. iron pipe, 50 lbs. to the foot, 66 2-3 cts. per lin. ft.

CEDAR BLOCKS.—Detroit, Mich.—The contract for furnishing the city with cedar blocks during the year has been awarded to David Watson at $8.38 per cord.

STREET WORK.—East Orange, N. J.—The contract for improving William St. has been awarded to Wright & Lindsley, as follows: Macadamizing, $1.32 per sq. yd.; guttering, $1.75; curbing, 35 cts. per lin. ft.; corner stones, $6.50. The contract for cross walks on Main St. was awarded to Patrick McCann, at 39½ cts. per sq. yd.

Stevens' Point, Wis.—A contract for 20,000 sq. yds. of cedar block paving has been awarded to Frank Wheelock, as follows: For pavement, 78 cts. per sq. yd.; stone curbing, 53½ cts. per lin. ft.; plank curbing, 13 cts.

Lexington, Ky.—Contracts for paving have been awarded as follows: Standard Construction Co., Lexington brick on concrete, $1.67 per sq. yd., Porter re-pressed brick on concrete, $2.15 per sq. yd.; Southern Construction Co., Hallwood block on concrete, $2.29 and $2.31 per sq. yd.

ASPHALT PAVING.—Omaha, Neb.—A contract has been awarded to the Grant Asphalt Co., at $3.08½ per sq. yd. for a 2½-in. surface.

Augusta, Ga.—The contract for paving Broad St., has been awarded to the Warren-Scharf Asphalt Paving Co., of New York, at $2.70 per sq. yd.

STREET SUPPLIES.—Wilmington, Del.—Contracts have been awarded at the following prices: Granite blocks, $1.55 and $1.65 per sq. yd.; rubble stone, 29 and 34 cts. per sq. yd.; selected rubble, 67½ and 70 cts.; curb, 50 cts. per lin. ft.; bluestone gutter stone, 14½ cts. per lin. ft.; center stones, $3.60 each; gutter plates, 1.9 cts. per lb.; inlets, $4.75 to $14.50; manholes, $7.50 each; lamp holes, $2.25; catch basins, $3.50; river sand, $1.10 per load of 2,500 lbs.; cement, $1.16 and $2.95 per bbl. for Hoffman Rosendale and Alsen Portland, respectively.

SEWERS.—Freeport, Ill.—The lowest bids for two sewers were as follows: Wm. Ascher, 8-in., 43 cts.; 12-in., 60 cts.; 15-in., 89 cts.; 18-in., $1.14; total, $21,507; Thos. J. Mellon, 8-in., 40 cts.; 10-in., 60 cts.; 12-in., 75 cts.; 15-in., 90 cts.; 18-in., $1.20; 24-in., $3; total, $46,174.

WELL.—Stockton., Cal.—The contract for a 6-in. well at the sewage pumping station has been awarded to C. Munch, at 55 cts. per ft. for the first 100 ft., and 80 cts. per ft. thereafter.

DREDGING.—Washington, D. C.—The following bids have been opened by N. H. Farquhar, Chief of the Bureau of Yards and Docks, for dredging about 55,000 cu. yds. in the Eastern branch of the Potomac; I. P. Morgan & Co., of Washington, 14.9 cts., or 20 cts. per cu. yd., according to method of doing work; and F. C. Somers, of Camden, N. J., 16.4 cts., or 15.9 cts. per cu. yd.

Portland, Me.—The lowest bid for dredging about 30,000 cu. yds. in the Kennebec River at Beef Rock Shoal, received by Lieut.-Col. P. C. Hains, was that of Moore & Wright, of Portland, 17½ cts. per cu. yd.

CEMENT.—Pittsburg, Pa.—The County Controller has awarded the contract for 3,000 bbls. of Hoffman cement to Murray Bros., of Allegheny, at $1.20 per bbl.

BRIDGE WORK.—York Beach, Me.—The contract for a pile and timber bridge over Cape Neddick River was awarded April 15 to Charles H. Young and E. B. Blaisdell. Red oak piling, 3,792 lin. ft. of 12-in., driven, and 800 ft. of 10-in., driven. 26½ and 25½ cts. per ft.; 792 ft. of 12-in., bolted to ledge, 29 cts. per ft.; 107,083 ft. B. M. of spruce lumber, and the same quantity of white pine and yellow pine, $25.75, $26.50 and $33.25 per M.; 500 lbs. of wrought iron fittings, 8 cts. per lb.; 2,911 lbs. of bolts, nuts and washers, 5 cts. per lb.; 7,200 lbs. of castings, 2½ cts. per lb. The committee voted to adopt yellow pine throughout, the aggregate bid being $5,622 on the estimate for bridge 500 ft. long. It was voted to increase the length to 620 ft., which will increase all of above quantities proportionally. The bids are in each case for material measured in completed structure, the whole to be finished by July 20.

MISCELLANEOUS.

GRAVEL.—Washington, D. C.—Bids are asked until May 3 for gravel for the U. S. Naval Academy at Annapolis, Md. Edwin Stewart, Paymaster General, U. S. Navy.

IRON GIRDERS AND BEAMS.—Washington, D. C.—Bids are asked until April 27 for plate iron girders, rolled beams and connections for the Congressional Library. Bernard R. Green, Supt. and Engr.

PUBLIC BUILDINGS.—Washington, D. C.—Bids are asked until May 10 for the iron columns, steel and iron floor, ceiling and roof construction, etc., for the public building at Detroit, Mich. Bids are also asked until April 29 for the approaches of the public building at Eastport, Me., and until May 12 for the cut stone and brick work, iron and wood floor, ceiling and roof construction, etc., for the public building at Lowell, Mass. W. J. Edbrooke, Supervising Architect, Treasury Department. The House Committee on Public Buildings has reported favorably bills for 23 new buildings.

DAM.—Greenville, N. C.—Bids are asked until May 2 for the construction of a dam. D. H. James, Clerk. Comrs. of Pitt Co.

HARBOR WORK.—Milwaukee, Wis.—The contract for dredging, piling, etc., in South Milwaukee harbor has been awarded to McIntosh Bros. at about $20,000. It is intended ultimately to have an inclosed harbor, about 3,000 ft. by 1,000 ft., with five piers and six slips inside the breakwater.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Baldwin Locomotive Works, Philadelphia, Pa., have orders for 10 switch engines for the Philadelphia & Reading, 4 consolidation engines for the Buffalo, Rochester & Pittsburg, 2 engines for Nicaragua, and 2 rack engines for Italy; they have shipped 2 narrow gage engines to the Jaffa & Jerusalem road. The Schenectady Locomotive Works, Schenectady, N. Y., are building 10 ten-wheel engines for the Chicago & Alton. The Manchester Locomotive Works, Manchester, N. H., are building 25 engines for the Boston & Maine. The Lima Machine Works, Lima, O., are building a light engine for a Florida plantation. The Pennsylvania will build 10 ten-wheel engines at its Fort Wayne shops. The Chicago, Milwaukee & St. Paul is making arrangements to build its own engines at the West Milwaukee shops.

CARS.—The Ohio Falls Car Co., Jeffersonville, Ind., has an order for 550 freight cars for the Louisville, New Albany & Chicago, and 5 passenger cars for the Minneapolis & St. Louis. The Terre Haute Car Mfg. Co., Terre Haute, Ind., is building 500 stock cars and 300 ore cars for the Chicago & Northwestern, and 300 hopper gondola cars for the Pennsylvania. Northern Pacific Car Truck Co., Chicago, Ill.; $2,000,000; G. E. Morden, F. W. Parker and J. Elliott. Caswell Stock Car & Transportation Co., Chicago, Ill.; $4,000,000; Wm. A. Caswell, M. H. Naber and J. A. Phillips. Superior Fireproof Steel Car Co., Chicago, Ill.; $1,500,000; R. B. Cooper, R. W. Burns and W. J. Fairman.

THE F. J. P. BRACKETT BRIDGE CO. is preparing to build works at Glendale, O., near Cincinnati.

THE BERLIN IRON BRIDGE CO., East Berlin, Conn., has a contract to build a producer building for the Solvay Process Co., of Syracuse, N. Y. The building will be 50x100 ft., three stories high, built entirely of iron, the floors being made of plate iron.

THE LUNKENHEIMER BRASS MFG CO., Cincinnati, O., is preparing for the World's Columbian Exposition a display of its specialties in valves, lubricators, steam whistles, etc. The company reports business exceedingly brisk, and is receiving large contracts for special work for U. S. cruisers.

THE ABENDROTH & ROOT MFG. CO., New York, has furnished two 206-HP. Root water tube boilers to the Shattuck & Babcock Co. mill, De Pere, Wis. This mill is also using a large quantity of the Root spiral riveted water pipe.

THE COURTRIGHT HYDRAULIC MACHINERY CO., manufacturing the Courtright undulating water motors, has opened an office in the Rookery Building, Chicago. Pres., Charles G. Davies.

NEW COMPANIES.—Bayfield Construction Co., Bayfield, Wis.; $10,000; R. D. Pike and W. W. Downs. Shipman Automatic Freight Car Coupler, Kishwaukee, Ill.; $100,000; Richard A. Shipman, F. C. Johnson and D. H. Taylor. Railway Equipment Co., Chicago, Ill.; $100,000; C. Metterhausen, A. E. Woodward and Ralph Bottenus. Railway Fence Co., North Baltimore, O.; $10,000; J. L. Newcomer, Jeremiah Foltz and James A. Chapman. Trxillo Construction Co., Morris, Ill.; $300,000; U. C. Davis, C. R. Morrison and Edward Steep. National Electric Brake Co., St. Louis, Mo.; $50,000; Wm. Kolding and Geo. L. Van Beck.

CURRENT PRICE LIST.

RAILS.—New York: $30 at Eastern mills, $30.75 at tidewater; old rails, $20 for iron and $14 to $15 for steel; girder rails, $40. Pittsburg: $30; old rails, $21 for iron and $16 to $16.75 for steel. Chicago: $31, old rails, $19.50 for iron and $13.50 to $14 for steel.

TRACK MATERIALS.—New York: steel angle bars, 1.65 to 1.7 cts.; spikes, 1.95 to 2 cts.; track bolts, 2.6 to 2.75 cts., with square and hexagon nuts. Pittsburg: splice bars, 1.75 to 1.8 cts. for iron and 1.8 to 1.9 cts. for steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.8 cts. for iron and steel; spikes, 2.1 to 2.2 cts.; track bolts, 2.65 to 2.75 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 57 1-2 and 47 1-2 per cent. on black and galvanized butt-welded; 67 1-2 and 55 per cent. on black and galvanized lap-welded. Casing, 55 per cent.

FOUNDRY AND PIG IRON.—New York: $14 to $16. Pittsburg: $14 to $15. Chicago: $13.50 to $15.50.

LEAD.—New York: 4.2 to 4.3 cts. Chicago: 4 cts. St. Louis: 4 to 4.05.

STRUCTURAL MATERIAL.—New York: beams, 2.3 to 2.8 cts.; channels, 2.25 to 2.5 cts.; angles, 1.9 to 2.1 cts.; tees, 2.4 to 2.75 cts.; sheared iron plates, 1.85 to 2.25 cts.; steel plates, 1.85 to 1.95 cts. for tank, 2.05 to 2.25 cts. for shell, 2.35 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 2.1 to 2.2 cts.; channels, 2.1 to 2.2 cts.; angles, 1.85 to 1.9 cts.; tees, 2.5 cts.; universal iron mill plates, 1.9 to 1.95 cts.; sheared steel bridge plates, 1.9 to 2 cts.; refined iron and steel bars, 1.75 cts.; steel plates, 1.9 cts. for tank, 2.1 cts. for shell, 2.25 to 2.3 cts. for flange, 3.75 to 4.1 cts. for firebox. Chicago: beams, 2.25 to 2.5 cts. for standard, 2.37 cts. for small, and 2.7 cts. for 20-in.; channels, 2.25 to 2.5 cts.; angles, 1.9 to 2 cts.; tees, 2.5 to 2.6 cts.; universal plates, 1.9 to 2 cts.; sheared steel plates, 1.95 to 2 cts.; steel plates, 2.3 to 2.4 cts. for tank, 2.6 to 2.75 cts. for shell, 2.9 to 3 cts. for flange.